

The University of Chicago

THE GEOGRAPHY OF THE COFFEE INDUSTRY OF PUERTO RICO

A DISSERTATION SUBMITTED TO THE FACULTY
OF THE DIVISION OF THE PHYSICAL SCIENCES
IN CANDIDACY FOR THE DEGREE OF DOCTOR
OF PHILOSOPHY

DEPARTMENT OF GEOGRAPHY
AUGUST, 1947

By
DAVID STEPHEN CAMPBELL

CHICAGO, ILLINOIS

1947

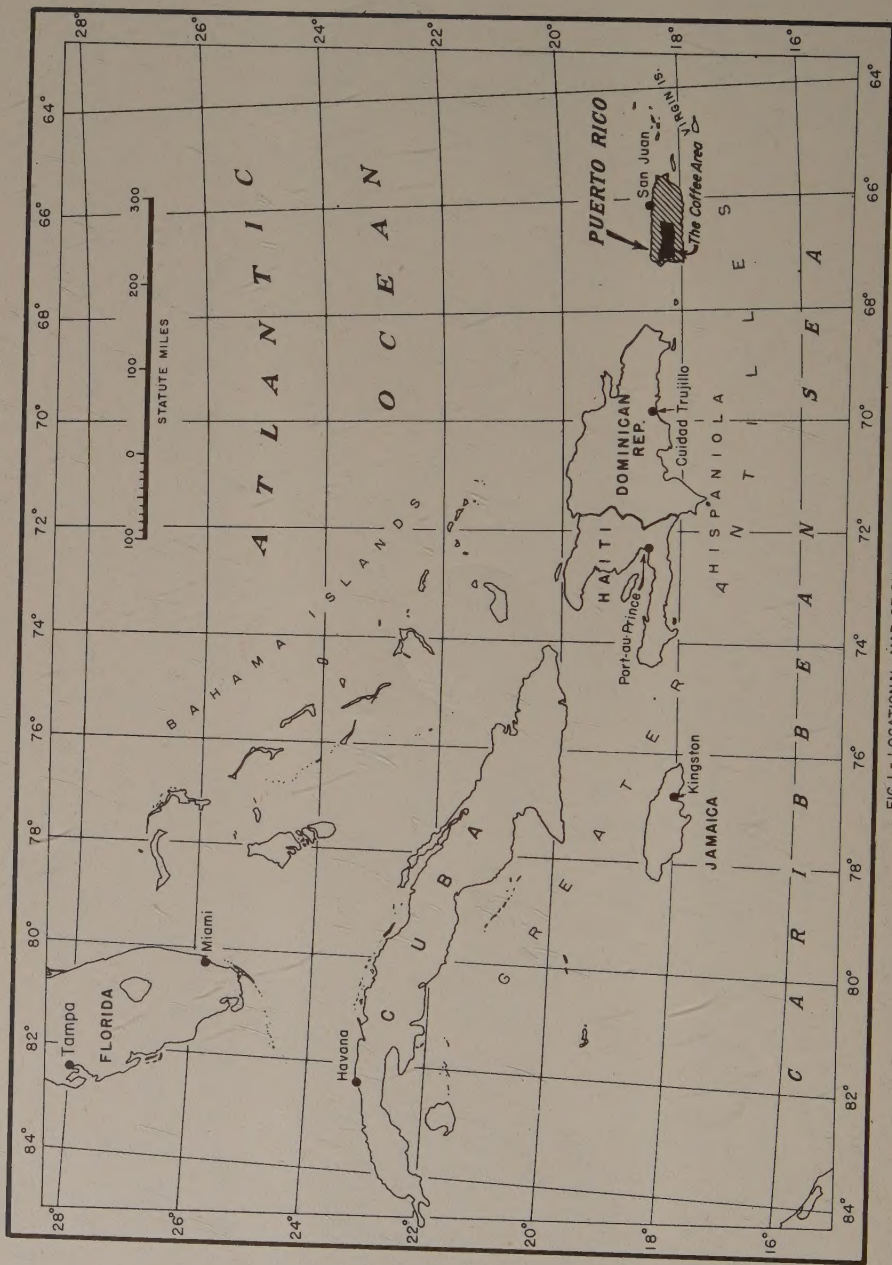


FIG. 1 - LOCATIONAL MAP OF PUERTO RICO

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NATURE AND SCOPE OF THE INVESTIGATION

The westward-sweeping tide of land settlement over the United States during the nineteenth and early twentieth centuries, the rapid technological developments of the past century, and the economic upheaval following World War I led to a number of maladjustments in the use of agricultural land. Each area had its problems. Each set of problems was different. A concerted effort to analyze and alleviate these problems took place during the 1930's. The economic depression of that era, with the concomitant low prices for agricultural products and financial despair of the farmer, dramatized the agricultural problems of the nation. The Federal and State governments took the initiative in developing programs of study, and many sciences, including geography, made important contributions to these programs.

During the same century and a half the revolutionary features of Western civilization spread over many other parts of the world, tropical and temperate, settled and unsettled, large and small, fertile and unfertile. These areas consequently developed new agricultural land-use problems. Some American and European geographers have been able to inspect a few of these areas at first hand and report on their observations. Intensive field work on small foreign areas has seldom been possible.

One segment of the world that has felt the effect of swiftly moving events is Puerto Rico, a Territory of the United States. In half a century this small (3,400 square miles) political entity has witnessed striking shifts in emphasis in its agricultural economy. The island's inclusion within the United States tariff wall and coastwise shipping laws, and the haven of American sovereignty provided favorable circumstances for the investment of American capital and energy in certain phases of Puerto Rico's agriculture. The character of this venture took the form of greater intensity of land use, increased preoccupation with commercial agriculture, and the consolidation of small land holdings into larger units.

While the insular agriculture was thus being revised by the direct effect of American political dominance, indirect forces having their basis in changing economic conditions elsewhere in

the world were also at work. One phase of Puerto Rico's agriculture, the coffee industry, affords an opportunity to inspect the impact of these forces, to assess their effect, and to develop the essentials of a future land policy.

Puerto Rico is supported almost entirely by agriculture. Sugar cane, tobacco, and coffee comprise, in that order of importance, the principal elements of commercial agriculture in the island's economy. Though ranking a poor third to these crops, the coffee industry, nevertheless, gives a livelihood to about 310,000 people, or a sixth of the island's population; employs 7 per cent of the total number of workers, or 10 per cent of the total employed in agriculture; furnishes 10 per cent of the island's direct income from agricultural crops; provides a crop for 41 per cent of the island's farms; and accounts for 16 per cent of the total capital invested in farm lands and buildings.

Coffee is believed to have been introduced into Puerto Rico from Martinique in 1736. From then until 1898, production of the crop increased. When Puerto Rico came under the American flag, coffee cultivation was the second most important commercial enterprise in the island, supplying about 20 per cent, by value, of Puerto Rican exports. During the intervening half-century, the industry has declined markedly in importance, both relatively and absolutely, until in 1946 it produced less than the island's domestic needs, and ranked a poor third to the two leading crops, sugar cane and tobacco, in its contribution to the island's income.

The effect of this striking transition has been to create serious economic and social problems in the coffee-producing area. The onus of supporting a submarginal economy has been imposed upon the remainder of the population whose level of living is already very low as judged by United States standards.

The attention of the writer was attracted to the coffee industry during his residence in the island in 1942 while engaged as a member of the staff of the National Resources Planning Board. Reconnaissance field work over the coffee area, economically the most seriously afflicted agricultural area in the island; examination of written materials; and numerous consultations with persons having a knowledge of the industry revealed that certain critical links in the chain of thinking were missing, if a land policy was to be developed. Also, in several instances, bias and "old wives' tales" appeared to substitute for fact. Hitherto, no one had

pieced together and applied the unpublished research results of many widely scattered groups to the analysis of the industry's problems. Some important geographical distributions were unknown.

The primary objective of this dissertation is to provide as accurately as possible a geographical analysis of the problems of the coffee industry of Puerto Rico. The localization of the coffee industry is described and explained, as is also the interrelation between the industry and the rest of the island. Principal emphasis is given to geographical distributions and problems that are industry-wide, rather than to the intensive study of individual farm units. Accordingly, the gross land-use patterns are given more attention than minor land-use patterns. For lack of historical evidence, study of the areal patterns must be limited to the past decade.

The internal structure of the industry is discussed in order to secure the details of farm operations, and to give perspective to the larger problems. The discussion of each problem is followed, in so far as possible, by a statement of the method that has been devised for its alleviation.

The problems of coffee-marketing are important for upon the success with which the product is sold rests much of the welfare of the industry. Both the domestic and foreign markets are discussed, the latter emphasizing particularly the position Puerto Rican coffee occupies in the world market.

Finally, the problems are summarized, and the bases developed for a land policy. This is done with the realization that complete and detailed information is lacking on many phases of the industry, but with the knowledge also that research materials are more complete for Puerto Rico than for any other coffee-producing country, with the possible exception of Brazil. It is hoped that from this case study of the agricultural problems of a tropical region, a structure of thinking will have developed that will be relevant to those groups who question the wisdom of, as well as to those who strive for a means of, rehabilitating the coffee industry.

To tell this story it has been necessary to draw heavily on data in the files of the numerous Federal and insular agencies in Puerto Rico. These data are from published and unpublished reports, letters, and notes. Numerous visits to farms during the spring, fall, and winter seasons provided a firsthand, working

knowledge of the system of coffee-farming. Interviews with farmer and with persons in government and business furnished much of the mortar properly to bind the written materials. Library sources in Puerto Rico were supplemented by materials in the Library of Congress and the library of the U.S. Department of Agriculture in Washington, D.C., and by geographic theses dealing with Puerto Rico. Two sets of aerial photographs, one flown in 1936 and the other in 1941, were used in the field in connection with the study of land use. Interpretation of the latter provided much of the basis for the maps and discussion in chapter 11.

The initial field work was accomplished between February and April, 1942. Subsequent field work was undertaken in November 1945, and again between March and May, 1946. In the conduct of this investigation, the area of the island gave reasonable dimensions to the basic field study. The small size of the island and the simplicity of its economy facilitated comparisons and made it possible to see most of the producing area. On the other hand, the tragically limited income of most of the producers, the inadequate statistical materials, the transportation problems inherent in the rugged topography, and the necessity of appraising problems set in the environment of another culture made the analysis more difficult. On the whole, however, the friendly interest and co-operation of many persons in the island facilitated the progress of the investigation and the statement of the conclusions.

I am especially indebted to Dr. Rafael Picó, Mr. J. Guis-cafré-Arrillaga, Dr. Kenneth Bartlett, Messrs. Ramiro Colón, Sol Descartes, Walter Packard, R. Colón-Torres, and David Powell, and Dr. Lawrence Witt for productive discussions. Messrs. Frederic P. Bartlett and Ralph Will read critically the nature and scope of the investigation and the last chapter. The writer assumes, however, full responsibility for all statements and conclusions. Mr. U. S. Allison very kindly made the 1936 aerial photographs available for study. Mr. Roberto Huyke and his staff of extension agents gave freely of their time. Mr. Frank Wadsworth examined and criticized the map of land use. Figures 3, 10, and 11 are furnished through the courtesy of the Puerto Rico Office of Information, photos by Roskam. The Office of Foreign Agricultural Relations, U.S. Department of Agriculture, afforded the writer the privilege of status as collaborator while he was writing the manuscript during the summer and fall of 1946.

This study was initiated under the supervision of Dr. Robert S. Platt, and, in his absence from the University, was completed under the direction of Dr. Charles C. Colby, who deserves special thanks for his interest in the study and for his stimulating and incisive criticism. My parents, Mr. and Mrs. D. H. Campbell, and my parents-in-law, Dr. and Mrs. D. L. Crawford, lent encouragement at all times. Finally, I am ever grateful to my wife, Joan C. Campbell, who so willingly shared in this task.

David S. Campbell

Washington, D.C.
March, 1947

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CHAPTER I

COFFEE IN THE AGRICULTURE OF PUERTO RICO

Puerto Rico is located on the northern periphery of the tropical lands in the Western Hemisphere, and is situated at the eastern end of the Greater Antilles, near the northeast corner of the Greater Antilles-Lesser Antilles alignment. The island is approximately rectangular in shape, with an over-all length of 113 miles from east to west and an average width of 41 miles. It lies between 17°55' and 18°31' north latitude and 65°39' and 67°15' west longitude, approximately 1,400 nautical miles southeast of New York and 525 nautical miles north of Caracas, Venezuela.

The economic base of the island, supporting two million people, consists almost exclusively of agriculture. One can observe from a plane at high altitude a regional grouping of agricultural activities, a display in which coffee, as well as other crops, comprises conspicuous features in the landscape. Coffee lands with their tall, heavily foliated shade trees form a dense dark-green carpet over the west central mountains. The diamond-shaped drainage ditches that are peculiar to and identify the tobacco fields dot the hills in the east central highlands. Fields of pale green sugar cane, superimposed on the coastal plain, rim the island. Patches of coconut trees, laid out in checkerboard pattern, lie here and there along the north and northwest coasts. Small fields of pineapple may be seen not far inland from the central portion of the northern coastal plain. Pastures of grass and brush, pinpricked with plots of cultivated fruits and vegetables, fill in the spatial arrangement.

As may be inferred from this pattern, agriculture in Puerto Rico is characterized by specialization in and dependence upon three major crops. Sugar cane is outstandingly important in the economy. Tobacco and coffee rank a poor second and third, respectively. All depend for existence upon subsidies of one type or another. The crops that constitute this agricultural triad have a high monetary value and are produced in quantities sufficient to provide an exportable surplus. The continued cultivation of these

crops has been in regard for the large market in the near-by United States with which the island is economically and politically oriented, and in response to the need for "exchange" with which to import food and manufactured products. It is noteworthy that normally most of the exported coffee is sold in Europe, and that only a small share reaches the United States. In addition, however, the island grows crops high in food value largely for local consumption. Agricultural husbandry in Puerto Rico is also featured by the use of large amounts of unskilled, hand labor.

The various types of Puerto Rican agriculture differ widely in their ability to return a profit. In general, sugar production is a profitable venture, whereas tobacco-growing is a marginal enterprise. The coffee industry has been insolvent for a number of years. In each instance the income from these crops is influenced in large measure by the laws and economic conditions of the United States.

There are differences in the operational structure of each of the three major agricultural activities. On the one hand, there are large, highly co-ordinated land holdings operating under corporate structure. These are the sugar-cane plantations. On the other hand, there are small, independently owned fincas performing with little capital on a quasi-subsistence basis. Coffee farms are of this type. Sugar plantations depend very largely upon "foreign" capital for financing. All other types of farms, including coffee, rely primarily upon local wealth. Sugar companies have been effective in adopting modern, scientific farming methods, and in skilfully utilizing land. Coffee farmers, on the contrary, employ inefficient practices.

The Coffee Area

Regional Setting

The principal coffee-producing section of Puerto Rico, hereinafter referred to as the coffee area, is located in the heart of the western half of the island (Fig. 1). The over-all dimension of this area is approximately 52 miles from east to west, and 18 miles from north to south, covering an area of about 935 square miles, or 35 per cent of the island's expanse. Ninety-five per cent of the coffee grown in Puerto Rico is produced in this area (Figs. 2 and 3). The remaining 5 per cent is scattered in small

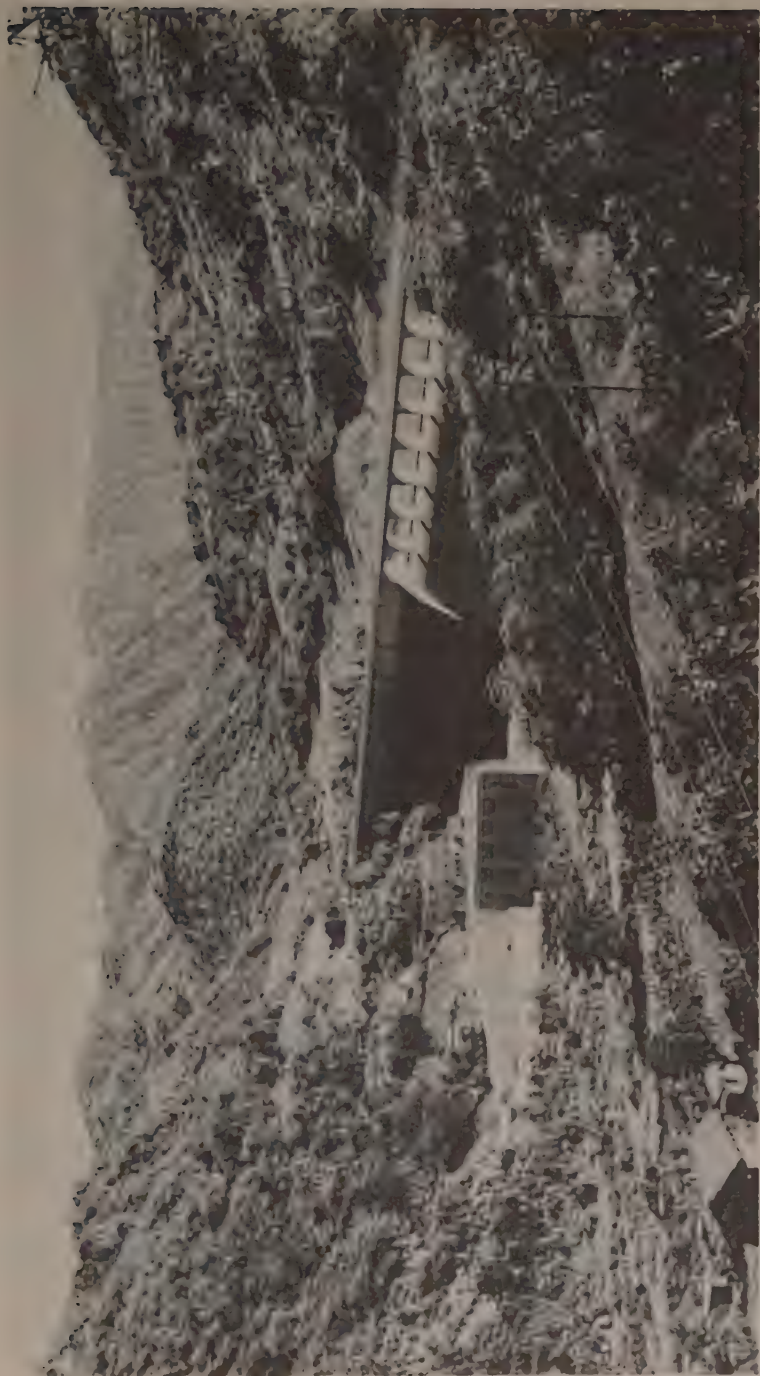


Fig. 3.--View of coffee area in the vicinity of Utuado. Shade and coffee trees cover the mountains in the background. Note the heavy silting in the Dos Bocas Dam reservoir.

patches over the highlands for 50 miles to the east. These patches are mere condiments for the major ingredients, tobacco, minor fruits, and animal husbandry.

The homogeneity of the coffee area is found in the broad similarity of its landforms and land-use complex, in the uniformity of the parent materials forming the soil series (Fig. 4), in the climate, and in the common agricultural problems. Microgeography on the other hand, reveals heterogeneity in the area. There are striking variations within short distances in relief, elevation, and soil types, because of correspondingly abrupt differences in slope and climate. The land-use complex on a ridge, a valley, or a plain may be quite different from that on contiguous land. Large variations in the size of farm units and fields are more typical of the area than is similarity in size. Differences in the ratio between the amount of land in crops and in the livestock proportion from farm to farm are the rule, rather than the exception. Crop yields and farming efficiency range between wide limits.

Columbus is said to have crumpled a piece of paper to illustrate the appearance of Puerto Rico for Queen Isabella. Aside from whether history has accurately recorded this incident, the analogy is close, particularly for the coffee area, because the most striking single feature of the topography of this area is its highly dissected mountainous character.

Along the entire southern side of the area stretches the Cordillera Central, a mountain range that rises to elevations above 3,000 feet and attains 4,400 feet at Cerro de Punta, the highest peak on the island, about four miles south of Jayuya. The Cordillera, complexly eroded, is characterized by rounded crests, steep soil-covered slopes, precipitous and narrow ravines, numerous mountain spurs, and small waterfalls. Stretching northward from the Cordillera is a dissected peneplain in which the mountain crests and valleys broaden.¹ Elevations decrease until at the northern edge of the coffee area the land surface is but a few hundred feet above sea level.

The stream pattern is dendritic. The streams are numerous and in constant flow, and most of them rise in the Cordillera and

¹H. A. Meyerhoff, "Geology of Puerto Rico," Monograph of the University of Puerto Rico (Rio Piedras: University of Puerto Rico, 1933), p. 24.

flow either to the north or west. The rivers are short, rapid flowing, and unnavigable, except for short distances in a few places by very small boats.¹ The largest of the rivers are the Añasco, Culebrina, and Arecibo. Several excellent dam sites for hydroelectric power plants occur along the mountain streams. These rivers, disease-ridden and inconvenient to draw upon as they are, constitute the major source of water supply for the inhabitants and their farming operations.

The vegetative cover was largely a tropical rain forest at the time the island was discovered. It is believed that the Caribs and the Arawaks cultivated but a small acreage prior to 1493. The local demand for timber and the search for agricultural land by a growing population led to the gradual destruction of the forest and to the substitution of coffee with its shade trees, and other agricultural crops. The present vegetative cover is largely tree and grass, for there is little land in this area planted to clean-tilled crops. Toward the margins of the area the land is somewhat more open (see chap. 11). Most of the cleared spaces indicate pasture land, but small patches of land under cultivation for such crops as bananas, plantains, and vegetables are common features of the landscape.

The soils of the coffee area² are lateritic, derived largely from tuffs, and, to a lesser degree, from granite (Fig. 5). They are purplish red to red in color, vary from one to thirty feet or more in depth, and are high in permeable clay, iron, and aluminum content. They are low in silica and organic matter. The surface soils are very acid to slightly alkaline and friable, while the subsoils are very acid, heavy, but permeable, and have adequate drainage for coffee plants.

The coffee-area soils belong to the great soil group of the red and yellow podsoles. The soil series³ within this group

¹The maximum discharge of the streams in the coffee area is from 10,000 to 20,000 second-feet during the rainy season, and the minimum discharge is from 250 to 1,500 second-feet. H. M. Wilson, "Water Resources of Puerto Rico," U.S. Geological Survey Water Supply and Irrigation Paper, No. 32 (Washington: Government Printing Office, 1899), p. 26.

²For an excellent description of the soils of Puerto Rico see U.S. Department of Agriculture, Soil Survey: Puerto Rico (Washington: Government Printing Office, 1942), pp. 166-357.

³A soil series is a group of soil types that have certain physical and chemical properties in common.

that are common to the coffee area consist of the Alonzo, Catalina Cialitos, Jayuya, Los Guineos, Malaya, and Nipe. With the exception of the Jayuya, the above-named soils are derived from fine-grained volcanic rocks. The Jayuya soils are of granitic origin.

The Catalina, Cialitos, and Los Guineos clays are the dominant soil types. They encompass approximately three-quarters of the soils in the area. Of these types the Catalina clay, steep phase, and the Cialitos clay, steep phase, constitute about one-half the total area. They occur on slopes exceeding 50 per cent.

None of the coffee soils were extremely fertile at the time of the first Spanish settlement and since then the land has been subject to much abuse. There have been tropical rains and hurricanes. Cultivation without adequate provision for conserving the soil expedited erosion. The land is now deeply eroded, there being few places in the area where an "A" horizon can be found. The soils are therefore low in organic matter. The situation is not worse because soil development is rapid owing to the heavy precipitation, high temperatures, and the inherent friability of the parent material. The most productive soils in the area are situated on concave slopes where soil accumulation has occurred as a result of sheet erosion.

The climate of the coffee area is of the tropical wet and dry type. The heavy annual precipitation, varying between 85 inches in the north and east and over 105 inches at Maricao, attains a maximum in summer and a minimum from December to March (Table 1 and Fig. 6).¹ The temperature averages about 76° annually

¹Olof Jonasson lays down the climatic limitations for the growth of coffee.

"The interaction of high temperature with other conditions particularly high humidity, set the equatorial limit of coffee production in tropical regions the world over, where rainfall is adequate, at the 27° c. (80.5° F.) isotherm for the warmest month of the year. Beyond that limit the climate, as a rule, becomes too warm and humid, and therefore the 27° c. isotherm may be considered the humidity limit for coffee production at that and higher temperatures. Of the annual isotherms, the 25° c. (77° F.) for the year corresponds most closely with that limit, and in case monthly temperatures are not available the 25° c. annual isotherm can be substituted for the 27° c. annual isotherm for the warmest month

"The cold limit for coffee production corresponds most closely with the 13° c. (55° F.) isotherm for the coldest month. . . . The element of prime importance in this limit is that the coffee trees shall not be damaged by frost

"As an approximate lower limit for the demand that coffee

at the outer margins of the area and decreases to 68° along the Cordillera. The average monthly temperatures fluctuate between a narrow range (from 5° to 8°) with a regime that denotes a maritime type of climate (Figs. 7 and 8). Sea breezes occur during the day and land breezes at night. The climatic conditions at the higher elevations, especially above 1,500 feet, are excellent for the growing of coffee. At the lower elevations near the western edge of the coffee area, the temperatures are too high for the production of good quality coffee. The great climatic handicap is the hurricane. Winds of one hundred miles or more per hour, accompanied by rain (10 to 30 inches within two or three days), cause extensive damage to the coffee and shade trees and to the soil. Hurricanes that pass within one hundred miles or less of the island are damaging. The record of hurricane occurrence--those that have passed across the island--is as follows:

TABLE 3

RATE OF HURRICANE OCCURRENCE IN
PUERTO RICO, 1658-1946^a

Period	Number of Hurricanes
1658-1708	0
1709-1758	9
1759-1808	18
1809-1858	14
1859-1908	10
1909-1946	<u>6</u>
	57

^aSource: Puerto Rico: A Plan for the
Protection of the Agriculture of Puerto
Rico against Hurricanes.

culture makes upon moisture, in other words the drought limit, the isohyet of 1,000 mm. (40 in.) annual average suffices. This criterion is untrustworthy in itself for it must be considered in relation to the rate of evaporation for each region Of major effect also is the occurrence of a definite drought period, particularly for growth of the coffee trees and the tillage of the soil, to say nothing of the ripening and harvest of the berries, their preparation, drying, and so forth. A warm winter-drought climate appears to be particularly favorable for the thriving growth of the coffee tree. If the rainfall comes at a season when the coffee trees most need it to grow and thrive, then coffee can be grown in sections where the annual precipitation falls somewhat below 1,000 mm. . . . An excessively heavy rainfall in a country does not necessarily prevent completely the growing of coffee; but as a rule an annual rainfall of more than 3,000 mm. (120 in.) indi-

Thus, during the past 287 years a hurricane has occurred on the average of once every 5 years. Not all of these struck the coffee area. The most recent hurricane to strike the island and the coffee area was in 1932.

The penetration of agriculture into the area and the introduction of the mongoose¹ into the island have virtually eliminated all wild-animal life. The mongooses have become so plentiful that they are a pest, destructive of fowl. Rodents remain in small numbers, although in large enough quantity to damage crops. Birds are scarce.

A few macadamized roads wind tortuously across the rugged terrain (Fig. 9). However, the vegetative cover is so dense with foliage that these ribbons of communication cannot be traced from the air throughout their length. Here and there dirt roads and footpaths, connecting or serving fincas, or farms, weave across the landscape to form a confused network (Fig. 10).

Most of the houses in the coffee area are hidden from view by the shade trees, but clusters of a few buildings with a coffee-drying floor alongside may be clearly distinguished. They signify the owner's home and center of farm activity. Here and there in the more remote sections of the area these centers may be comprised of ten or fifteen buildings, most of them homes for the farm workers. Lone houses made of rough lumber, perched on hilltops or set upon a narrow bench in the hillside, dot the landscape in a dense and intricate pattern (Fig. 11). These belong to the agregados, or landless squatters, who provide labor for the fincas. In most cases these rural homes are located on the least valuable and commonly the most inaccessible section of the farm.

Population Characteristics

The population is a composite of (1) Indians native to the island at the time of its discovery. The great majority of this element, estimated originally to number about 30,000, was almost completely decimated in the first few years of Spanish colonization.

cates lack of a dry season, at least of any consequence, and so the annual isohyet of 3,000 mm. may with some propriety be considered the rainfall or moisture limit of production." Olof Jonasson, "Natural Conditions for Coffee Culture," Economic Geography, IX (October, 1933), 359-60.

¹Imported from Cuba in 1877.



Fig. 10.--A macadamized road in the mountainous coffee area.
Horses are a favorite means of transportation over the rugged terrain.

There were perhaps two or three hundred Indians remaining by 1510. (2) Spanish colonists who came to the island primarily during the sixteenth and seventeenth centuries. Small numbers of colonists continued to arrive throughout the eighteenth and nineteenth centuries. (3) African slaves, brought in greatest numbers during the nineteenth century; and (4) a miscellaneous group of immigrants from such areas as Venezuela, Cuba, Mexico, and southern United States. These immigrants also came in largest numbers during the nineteenth century.

The population of Puerto Rico twice doubled in the past century. By 1939 the island had a population numbering 1,862,255. The scarcity of land is indicated by the population densities of 546 persons per square mile, and of 809 persons per square mile of arable land.¹ Only Barbados, Grenada, and Martinique in the Caribbean have a population density that exceeds that of Puerto Rico.² In the coffee area in 1939 there were 347 persons per square mile, and 610 persons per square mile of arable land, densities somewhat less than for the island as a whole (Fig. 12). The lower population densities in the coffee area are accounted for by (1) the lower demand for labor per acre of coffee than for most of the other crops in the island, (2) the small urban population of the area, and (3) the migration of the population to other parts of the island in search either of alternative types of employment, or for the enjoyment of the city's social activities.

The population of Puerto Rico increased 21.1 per cent between 1929 and 1939. In the same period the population of the coffee area increased only 13.5 per cent, because of emigration greater than the natural increase. The birth-rate of Puerto Rico in 1939 was 38.7 per 1,000 persons, and the death-rate 18.4 per 1,000 persons, or a net increase of 20.3 per 1,000 people. At present this rate of growth shows no tendency to level or taper off. However, the "bell-shaped" pattern of population growth may, in time, develop. At the current rate of increase the number of people in the coffee area is increasing about 8,000 annually.

¹U.S. Bureau of the Census, United States Census of Agriculture: 1940. Farms, Farm Property, Livestock, and Crops, Puerto Rico (Washington: Government Printing Office, 1942), p. 13.

²F. P. Bartlett and B. Howell, The Population Problem in Puerto Rico (Santurce: Puerto Rico Planning, Urbanizing, and Zoning Board, 1944), p. 11.



Fig. 11.--View of hillside with houses, showing the density of the rural population. The brush pasture is typical of the pasture land throughout the coffee area.

The population in the coffee area was approximately 310,000 in 1939.¹ This number is rather evenly distributed throughout the area (Fig. 12). The sections of sparse settlement are zones of very rugged relief, rock outcrops, or low rainfall, making them unsatisfactory for agricultural use.

The urban population of the coffee area comprised 11.6 per cent of the total population of the area in 1939, as compared with 30.3 per cent urban population for all Puerto Rico. With such a small percentage of persons in urban communities, Figure 12, representing the combined rural and urban distribution of the population, also very closely portrays the distribution of the rural population.

The urban population of the coffee area, numbering 26,368 in 1939, is divided among ten small, compactly built towns. The size of these towns ranged from 391 persons in Las Marias to 4,302 persons in Lares (Fig. 13). There are no unincorporated villages in the coffee area as there are in the rest of the island. Here and there along the main roads, aligned in "strassendorf" manner, are half a dozen or more houses, with perhaps a ventorrillo, or small store, serving as a small market center.

Each town is a political center for a municipio, or municipality,² bearing the same name, and is also a market center, both for the purchase of goods and the sale of farm crops by persons within the surrounding rural community. There is no industry in any of the towns save for a few establishments making such items as baked goods, tobacco products (in the towns near the tobacco-growing area), and stone and clay products. All these activities are carried on in small shops employing only a few persons.

¹A determination of the population in the coffee area defies accurate calculation for the reason that the regional boundaries of the area do not coincide with the political boundaries used as a basis for the census enumeration. This figure was obtained by totaling the population of the municipalities wholly and largely within the coffee area, and subtracting the urban population of the latter group of municipalities where the urban centers were located outside the area.

²A municipio is a civil division corresponding to the county in the United States; a barrío is a minor civil division comparable with the township.

Occupational Structure

The lack of conformity between the bounds of the coffee area and the limits of the census-enumeration districts precludes an accurate account of the coffee area's occupation structure. However, the large sample selected for use in Table 4 is closely indicative of the structure for the area's entire population. In this table, data are given for both the coffee area and Puerto Rico for comparative purposes.

A total of 49,654 persons, male and female, are employed in the area represented by this sample, out of a total population of approximately 180,000. Assuming the ratio between the employed persons and the total population to be the same for the entire coffee area, there are about 86,000 employed persons in the coffee area.

Of this selected sample 59.5 per cent of the employed persons worked on farms. The remainder had employment in non-farm activities that relied almost exclusively on forms of employment that are indirectly related to the farm. Appropriate proportions of persons working on the major crops cannot be derived for the reason that coffee, sugar cane, and tobacco farms as used by the census in this table are defined on the basis of the crop contributing the greatest revenue to the farm. A mixed farm must be listed under one of the three categories, irrespective of the labor employed on the different crops.

Contributions of the Coffee Area to the Remainder of Puerto Rico

The coffee area is closely interwoven into the fabric of the Puerto Rican economy. As is to be expected, the coffee area both contributes to and receives benefits from other areas of the island. For example, just as the coffee area furnishes Puerto Rico with its coffee, except in occasional years when yields are very low owing to the occurrence of a hurricane or other unfavorable weather conditions, the sugar-cane industry supplies the entire island with sugar. Native-grown tobacco is made into cigars and chewing tobacco, though not cigarettes, for the population. Some of these contributions are measurable in terms of money or pounds of food; others are less capable of concrete evaluation. The contributions of the coffee area to the remainder of Puerto

Rico may be discussed in terms of crop, income, and labor.

Crop Contributions

The boundary of the coffee area is not sharp. Coffee lands blend into adjacent agricultural areas. This is especially the case along the southern and eastern margins. Along these zones of transition coffee is produced as a complementary crop in a system of farming that has another crop as its major emphasis. In these cases, land is used for coffee that generally is topographically unsuited to any other crop grown on the farm. This adjustment to the environment, therefore, nets a greater income to the farmer and to the island than from any other use, such as forest or pasture, to which the land might be put.

Coffee culture, irrespective of location, in another way contributes to the insular economy. Coffee fincas provide a reservoir of a wide variety of foodstuffs that are distributed to markets throughout the island. In the vicinity of Jayuya and Utuado a small group of farmers specializes in the production of tomatoes for export to the fresh-vegetable market in the United States. A coffee plantation is more diversified than the sugar cane or tobacco farm in its cropping system. Supplementary food crops, such as oranges, bananas, and plantains, conveniently are grown on the same land and at the same time as coffee, as an integral part of the farm organization. Names, yautias, and other vegetables are produced on independent plots. The production of citron and vanilla also add to the list of the foods grown in the area. Chickens, pigs, and goats are also raised in surplus quantities. Furthermore, the coffee area is the primary source for the island's charcoal, obtained from the old shade trees that are periodically cut. Charcoal is used almost exclusively as fuel for cooking in Puerto Rican homes.

The population of the coffee area, living in a surplus-food-producing section, is somewhat better nourished than the inhabitants of the other sections of the island. Fruits and vegetables are readily obtainable, and furnish an important supplement to the staple diet of imported rice, beans, and codfish.

Income Contributions

It is difficult to measure precisely the contribution the coffee area makes to the income of the island. The trade of a

region can seldom be subject to the accurate scrutiny that is possible with a political state. Furthermore, no comprehensive territorial income study, a complex assignment, has been made of Puerto Rico, and the material for such a study is both difficult to obtain and is beyond the scope of this study. An approximation of the wealth rendered by the coffee area can be reached by comparing the value of production of the three primary agricultural products, as shown in Table 5.

TABLE 5

VALUE OF SUGAR, MOLASSES, RUM, TOBACCO, AND COFFEE
PRODUCTION IN PUERTO RICO, BY YEARS, 1931-43^a

Year	Value of Sugar, Mo- lasses, and Rum Exports	Value of Tobacco Production	Value of Coffee Production	Per Cent of Coffee Value to Total Value
1931-32...	\$60,435,106	\$ 704,400	\$2,650,701	4.39
1932-33...	54,987,304	1,919,752	2,577,818	4.33
1933-34...	60,103,543	3,545,000	2,035,800	3.10
1934-35...	51,726,126	3,874,000	2,076,800	3.60
1935-36...	67,839,329	3,983,200	4,026,000	5.31
1936-37...	80,013,718	5,233,474	2,879,287	3.27
1937-38...	58,177,415	5,204,810	3,114,858	4.68
1938-39...	61,359,677	2,330,933	2,723,000	4.10
1939-40...	68,145,487	3,895,674	2,721,068	3.64
1940-41...	71,086,037	Not available	1,762,560	-
1941-42...	80,214,192	5,400,000	4,107,508	4.58
1942-43...	73,931,517	3,109,260	2,416,657	3.04
Average 1931-43..	65,668,287	3,563,682	2,757,671	3.83

^aSource: Annual Book on Statistics of Puerto Rico, 1942-43.

This table does not take into account the value of sugar, molasses, and rum that is consumed domestically. However, on the basis that sugar cane, tobacco, and coffee furnish about 70 per cent¹ of the island's income from agriculture, coffee contributes about 5.5 per cent of the total. This is not the complete story for, as has been stated, a number of fruits and vegetables

¹E. B. Hill and S. L. Descartes, An Economic Background for Agricultural Research in Puerto Rico, Bulletin No. 51. (Rio Piedras: Agricultural Experiment Station, 1940), p. 16.

are grown in the coffee area as complementary crops and their value should be included in any income estimate. When, therefore, the values of livestock, fruits, vegetables, and charcoal are added, the coffee industry is responsible for about 10 per cent of the direct income from agriculture, or on the average of about \$5,000,000 annually.¹ This proportion scarcely varies from year to year. However, there are wide differences from year to year in the monetary value of the crops grown on coffee farms.

Aside from fluctuations in crop yields, the income of the coffee area varies, in part, with domestic and, in part, with world economic conditions. Coffee produced and sold in Puerto Rico is sold in a market protected by an insular tariff, and, for several years past, by a Federal subsidy. The tariff is constant, while the cash subsidy is variable. Coffee for domestic consumption, therefore, is sold at a price no less than the combined subsidy, but also at a price that fluctuates widely above the subsidy level. Any surplus coffee that is sold in the open market abroad is subject to the same international supply-and-demand factors as coffee from any other country, and for an amount that varies widely from year to year. On the other hand, the other crops that are produced on coffee farms are sold locally without subsidy, and are subject to great variation in price because of changing economic conditions on the island. Such factors as changes in the quota allotment of sugar cane, modifications in the United States price for Puerto Rican-grown tobacco, and shifts in the volume of governmental expenditures, relief or non-relief, will alter the purchasing power of the Puerto Rican, and, thereby, the price he can afford for fruits, vegetables, charcoal, or meat.

Labor Contributions

The tragically low income of the Puerto Rican worker and the pressure of a large population on an island of low productivity are contributory elements compelling him to secure a job wherever and whenever one is available. A large proportion of the agricultural work performed in the island is unskilled, enabling the laborer from one area to perform, with little or no instruction, most types of work in other areas. The fact that Puerto Rico is small and is crisscrossed by a number of roads lends mobility to

¹Ibid.

its labor force. However, the jibaro in the coffee area is somewhat less mobile than the laborer in other parts of the island because the mountainous topography of his environment hinders communication between farm and road.

The mobility of agricultural labor within the coffee area is of two types. The first of these is seasonal in nature. During the sugar-cane-harvesting season, which begins in January near the close of the coffee-picking period, there is an exodus of workers from the coffee area to the sugar-cane-producing sections along the coast. There is no clue to indicate how large a proportion of the coffee labor force is thus involved, but at least the number potentially available is large because of the sharp decrease in the demand for labor in the coffee area at this time. The migration is reversed after June as the cane-grinding period comes to a close, and the workers return to the mountains.

Prior to 1898, when coffee was the major crop in the island, and sugar cane occupied a smaller acreage and employed fewer persons than at present, there was a migration in opposite directions. Sugar-cane workers moved to the mountains in the fall to supplement the labor supply of the area in the coffee-picking season, and returned to the cane fields in January.

A temporary, though not seasonal, labor shift may also occur when relief projects are launched near the coffee area. These measures, undertaken to absorb unemployment, attract the jibaro for as long as work is available. Often the regularly employed coffee worker is drawn to these special projects for the wages he thus receives are generally higher than those paid on the coffee finca.

The second type of labor mobility is of a more permanent nature. While, as has been pointed out, the population of the coffee area has annually increased, it has not grown as rapidly as in other parts of the island. Many workers have moved into towns outside the area or to other agricultural areas to remain indefinitely. This movement received a great stimulus as a result of the 1928 and 1932 hurricanes, when the coffee farms were severely damaged and employment opportunities consequently decreased. The migration continued at a slower pace through subsequent years. World War II was another powerful stimulus to farm-to-city movement. The construction of military installations, and the induction of local men into the armed forces drew many persons from all parts of the

island. In fact, during the war years, the coffee area was so depleted of labor that a part of the coffee crop was lost because of the lack of pickers during the harvest. This permanent migration also is due to the desire of the jibaro to participate in and enjoy the greater range of social activities incidental to town life, a motive that has caused a farm-to-city movement in many other countries on the globe. The migrants to towns are confronted with higher living costs than prevailed in the country. Many eventually settle in the town slums. Regardless of their deplorable living conditions, there is little evidence to indicate that these people return to the farm.

CHAPTER II

LAND-USE PATTERNS IN THE COFFEE AREA

Gross Functional Land-Use Patterns

The coffee area, centered in the west central highlands, is a cohesive type-of-farming unit where coffee farming is the dominant method of land use and source of farm income, and where 95 per cent of the island's coffee crop is grown. A thread is added to the pattern of land use by the distribution of a few specialty crop farms. Within a radius of one or two kilometers of each town are scattered dairy farms, comprising a small milk shed. Although fresh milk could be successfully brought from greater distances, this dispersion represents the most convenient distance that the product can be transported by pony or cart. Citron production is concentrated in the vicinity of Adjuntas, where there is a settlement of Mallorquinas to whom the cultivation of this crop is familiar. Farms specializing in the growing of tomatoes for the United States market are centered near Jayuya and Villalba.

The boundaries of the coffee area form an irregular but roughly rectangular design, the irregularity reflecting an adjustment to various physical factors, such as topography, soils, elevation, and rainfall, as well as to the economic factor of competition from other crops (Fig. 14).¹

¹Although Figure 8 does not show the distribution of all coffee land in Puerto Rico, the limits here chosen to represent the coffee area are those that enclose a territory producing 95 per cent of the coffee crop. The remaining 5 per cent is scattered in small plots over the highlands for about 50 miles to the east, and are minor sources of revenue, as well as of food, in other types-of-farming areas.

Figure 8 was compiled from aerial photographs taken in 1936 and available to the writer in mosaic form. The mosaics were used in the field and land use plotted, in so far as it was possible, from traverses along the highways. The inaccessibility of the rugged terrain precluded complete mapping of the area in the field. However, stereographic examination of the overlapping photographs in the library reduced the error of interpretation to a minimum.

Only the gross categories of land use were mapped for the

An examination in detail of the factors influencing the boundary pattern may begin at the northwest corner of the area and proceed clockwise. The northern boundary, extending from the town of Moca in the northwest to Morovis in the northeast, lies along the foot of an irregular escarpment rising several hundred feet in height (Fig. 15). The continuity of the east-west trending escarpment is interrupted at several places, as, for example, where rivers rising in the interior have cut through the formation. In these places triangular indentations have developed and appear as pointlike projections along this boundary. North of the escarpment are limestone-derived soils in a setting of karst topography. This land not only produces a poor crop of coffee, but also is more proficient at growing sugar cane. Here and there, however, a small patch of coffee may be planted between the stony, thin-soiled, "hay-stack" hills, so called, where soil development is adequate for cultivated crops.

The eastern boundary extends from Morovis south across the Cordillera Central, and continues south beyond Villalba for about two miles. This line has developed as a function of four factors. First, this limit closely marks the dividing line between the steep and rugged topography of the coffee area to the west and more rolling and rounded relief to the east. Thus, the land to the east is topographically adaptable to the production of tilled crops, comprising vegetables, minor fruits, and tobacco, which are more profitable to produce than coffee. Second, is a constant climatic factor. East of this boundary precipitation decreases below the amount (less than 85 inches) necessary to produce good yields and good-quality coffee. This is because elevations are higher along the western half of the Cordillera than along the eastern half and rainfall, derived from the easterly trade winds, is correspondingly lower in the latter section. Third, is an intermittent climatic factor, the hurricane. Prior to 1928 the coffee area extended further east than at present. In 1928, and again in 1932, the island was visited by hurricanes that severely damaged the eastern margins of the coffee area. Many of the coffee plantations thus

reason that the degree of legibility of the aerial photographs did not allow a further breakdown in the classification of the non-coffee land, nor did it permit a differentiation between the productive and nonproductive coffee land. To accomplish the latter, an intensive ground survey would be necessary.



Fig. 13.--The coffee town of Lares, as seen from the plaza.



Fig. 15.--The escarpment, northeast of Lares, marking the northern boundary of the coffee area. Coffee growing to the foot of the escarpment.

destroyed were cleared of trees and the land was planted to other crops or was permitted to grow up to grass for use as pasture, and the boundary line shifted to its present location. However, the shift does not appear to have been very great. A comparison of the census figures of land in coffee before and after the hurricanes indicates, if the census enumeration may be relied upon, that no more than 25 square miles of coffee were thus taken out of production. This acreage would result in the boundary shift of not more than two or three kilometers. Fourth, is the soil factor. The Alonzo, Catalina, and Cialitos, the dominant soils of the coffee area, occupy a progressively and markedly less extensive area east of this boundary. Soil types change to those of lighter texture and whose productivity rating is greater for vegetables and other minor crops than for coffee.

The southern boundary of the coffee area lies a few miles south of, and closely parallel to, the crest of the Cordillera. This line of demarcation extends from Villalba westward to Yauco, and thence northwestward to Mayaguez. Although the land between the crest and this boundary is in the rain shadow of the mountains, this strip receives sufficient rainfall for the growth of coffee. A generation and more ago the southern limit of coffee-growing, in the segment east of Yauco, reached further south. However, sugar cane and minor crops gradually replaced coffee plantations and pushed back the southern limit across the rolling relief of the foothills to its present position at the foot of the Cordillera. Between Yauco and Mayaguez is an expanse of Rosario soils, developed to a thin profile from serpentine rock, on which coffee is sparsely grown.¹

The western edge of the coffee area extends north from Mayaguez along a broadly meandering course to Moca. In places this margin reaches almost to the coast. The bases for the western boundary lie in the factors of soil, relief, climate, and competitive types of land use. The rich soils of the broad, level, alluvial valley at the lower end of the Anasco River, and the coastal plain widening south of Mayaguez are more remunerative if planted to sugar cane than to coffee. The city of Mayaguez, a port city

¹The productivity rating of Rosario soils for coffee is 15. Few productive coffee plantations are situated on this type of soil. Rosario soils contain some chromium and nickel that probably have a toxic effect on plant roots. These soils have a vegetative cover largely of grasses and shrubs.

in a partially protected indentation of the coastline, also comprises a competitive type of land use. This site is more valuable for urban use than agricultural. Near Mayaguez this western limit is at the lower slopes of the mountains where the prevailing high temperatures lower the quality, but not necessarily the yield, of coffee.

Between Añasco and Moca the boundary of the coffee area bends sharply, and extends toward the western coast of the island. This line does not follow the edge of the coastal plain, but, rather, rises into and cuts across the highlands. This is a climatic and a soil limit. Here the Cialitos coffee soils meet thin soils that can produce only subsistence crops or grass for pastures. Also, the annual rainfall decreases toward the west until it is below the 75 inches necessary for coffee plants.

Field work in 1946 in company with the aerial photographs flown in 1936 disclosed no appreciable alteration in the geographical limits of the coffee area during the past decade. Only small sections of coffee land, situated here and there along the northern and northwestern perimeter of the area, were cleared and put into sugar cane or some type of land use other than coffee. These sections are located in the vicinity of the towns of Añasco, Moca, San Sebastian, Las Marias, Utuado, and Ciales, generally within a kilometer or less of the highway for the advantages of easy transportation of the crop. The motive for shifting from coffee to sugar cane was to obtain a quick, high return from the production of the latter. In cases where the cane was planted on steep slopes, two or three crops were obtained before the soil eroded to the extent where the raising of additional crops was unprofitable. This land was then abandoned and grew a thin grass cover. On the less rugged terrain sugar-cane cultivation has continued without interruption. The alteration of the land-use pattern was continuing slowly in the spring of 1946. The aggregate acreage involved during the past ten years is not easily measured, but certainly is less than one or two per cent of the entire coffee area.

Modifications in the limits of the coffee area occurred prior to 1936. Before 1898 coffee was grown over a greater share of the mountains than at present. Accurate plotting of previous distributions cannot be made for lack of historical evidence.¹

¹Two maps showing a very generalized distribution of coffee at the turn of the last century are: "Chart of Comparative Areas

Former boundaries, however, were pushed back to their present location for various reasons. The shift in political control over the island in 1898 created changes in emphasis in the island's economic activities. The production of sugar cane and tobacco was stimulated. Land was cleared of coffee and pastures were plowed to make way for the new crops. The incursion of tobacco on the east was greater than that of sugar cane on the north, west, or south, because the expansion of the former was largely at the expense of the easily convertible pasture land. Hurricanes damaged coffee plantations, and many farms were not rehabilitated. The demand for land by a rapidly growing population led to the destruction of the trees for fuel, and the use of land for food crops. Thus, the present boundaries encompass the remnants of a once more widespread area. The coffee area now constitutes environmentally the least desirable lands for the growing of any major crop, except coffee.

There are variations in the gross pattern of land use from one part of the coffee area to another, as shown by the proportion of the land that is planted to coffee, productive and nonproductive (Fig. 14). In general, the area is densely covered with coffee plantings. There are, however, two outstanding exceptions in this pattern. The first is the large segment lying near the northeastern portion of the coffee area, surrounding the axis connecting Utuado and Jayuya. This section, aligned in a northeasterly-southwesterly direction, is approximately twelve miles long and between three and four miles wide. Within this segment land in coffee comprises a negligible proportion of the total area. This is an important tobacco-producing section. The reason for this distribution is that this is a section of granitic soils, known as the Jayuya series. They are light-textured and friable. Although they have a productivity-rating equally good for both coffee and tobacco, the latter is more profitably grown on them.¹

of the Staple Products of Puerto Rico, According to the General Assessment, 1902-3," in the map files of the Library of Congress, Washington, D.C.; and Wilson, op. cit., Plate XIII.

¹These soils erode very easily, especially if planted to tilled crops, such as tobacco and beans--so easily, in fact, that this section has the most perplexing soil-erosion problems of any district in the island. Gully erosion and slumping are severe. Modern soil-conservation science has to date been unable to devise a method that will prevent these types of erosion under conditions

The second important exception to the general pattern of a heavy proportion of the total land in coffee consists of the several segments of governmentally owned forest land. These are scattered along the crest of the Cordillera Central near the southern edge of the area. The ownership of this land is divided between the United States and Puerto Rican governments, with the larger acreage owned by the latter. These lands were acquired by purchase. They were selected for their very low soil productivity in order not to remove agriculturally usable land from production. These lands are being reforested to supply timber products to the island. It is planned that an additional, but undetermined, acreage of equally poor land situated near-by will, in due time, be added to these governmental holdings.

Aside from the aforementioned two cases, there are other differences to be noted in the pattern of land use. There is a thinning of coffee into small, separated plots at the northwestern extremity of the area in the segment west of San Sebastian and south of Moca. This pattern is due largely to the infiltration of sugar cane onto relatively rolling land. It is, however, also a section in which some infertile soils, capable only of producing grass, are to be found. Coffee trees occupy the most rugged terrain.

The section southeast of Mayaguez toward San Sebastian is largely in grass or brush pasture, reflecting the existence of soils, such as the Naranjito, poor phases of the Mucara, and rock outcrops, that are low in productivity for coffee. Also, the annual rainfall decreases rapidly south of the mountain crest along the western end of the Cordillera, and there is insufficient precipitation for coffee.

In the southeast there is also a sector about six by fifteen miles in breadth and length, stretching west of Villalba that is sparsely covered with coffee. Here there are rock outcrops, thin soils, and deficient rainfall in the lee of the mountain range. Grazing is the dominant agricultural activity on these slopes. Coffee is grown on the ridges and in the deep ravines.

of clean cultivation on these soils. A factor mitigating, however, the need at present for emergency control measures is that these granitic soils are deep enough, commonly as much as 50 feet, safely to permit a number of years of study in the control of erosion, before vigorous measures must be taken.

Also, southwest of Ciales there is an area of about twenty-five square miles where the Alonzo and Cialitos coffee soils intermingle with the Múcara, a soil on which subsistence crops are more profitably grown than coffee. In addition, a pattern of non-coffee land visible in the landscape is the Añasco River valley, whose alluvial soils are planted to cane. This valley can be traced for nearly half the length of the area.

Coffee plantations are most densely distributed along the Cordillera between Mayaguez and Adjuntas. This section comprises the heart of the coffee area. The steep slopes, the heavy precipitation, the high elevations, and the relative inaccessibility of the land make coffee the preferred commercial crop. Non-coffee land in this section is, in many cases, correlated with soil types, that are not productive for coffee.

Throughout the coffee area the boundaries of the coffee plantings have a pattern of extreme irregularity. No close correlation can be found between these boundaries and any physical factor. There is the tendency, however, for coffee to be grown on the land that is the most difficult to farm, and for the tilled subsistence crops, sugar cane, and, to a lesser degree, pastures, to be situated on the topographically more favorable land. Small patches of sugar cane may be grown on the alluvial soils collected in the narrow valleys. Around the perimeter of the coffee area, where coffee is interfused with sugar cane, tobacco, and minor crops, coffee is also customarily grown on the relatively inaccessible land, as, for example, on the tops of mountains, at the bottom of steep valleys, or on the most abrupt slopes, thereby acceding to the requirements of the other crops for superior land.

These land-use patterns have been quite firmly established for more than a decade.¹ A foreseeable event that will tend to alter the current pattern is the future road-construction program of the Puerto Rican government. Plans are made to build a number of new roads through the coffee area in order to provide better transportation facilities to the coffee farmer. Such a program, commendable as it is, will also result in some acreage of coffee being cleared and planted to sugar cane, regardless of the undesirability of growing tilled crops on these steep, easily erodable

¹A comparison of the 1936 and 1941 aerial photographs with 1946 field observations.

slopes. However, alterations in the pattern of land use that will thus accrue will probably be limited to distances of not more than one kilometer from the highway. Any greater distance would so increase transportation costs as to make the production of cane unprofitable.

Minor Functional Land-Use Patterns

The metes-and-bounds system of property description is in use in Puerto Rico.¹ As this would imply, the farm boundaries are very irregular and without system, following roads, ridges, valleys, streams, or ignoring physical and cultural features altogether. The boundary lines may be straight or curved--or both, as is more commonly the case. This jigsaw pattern had its origin during the period of Spanish colonization in the sixteenth century and has continued throughout the eras of Spanish and United States influence.² In fact the pattern has become more complex over the period of four and one-half centuries because of the many property transfers that have been made.

Farm boundaries are described with reference to adjoining owners rather than to landscape features. Property descriptions in the land titles are so vague that it is impossible to draw property lines from the legal descriptions. Land titles are difficult to trace, but satisfactory titles can be obtained.

A single farmer may own and operate several scattered farm units. They may be all coffee farms, or each may have fields of sugar cane, tobacco, and coffee. Any variation is, in effect, a method of crop diversification for the owner. The production of coffee and sugar cane on the same farm enables the owner to dovetail the seasonal demand for labor for the two crops, and thus to make more efficient use of his workers.

The intricate field pattern, while causing some inconven-

¹The Puerto Rico Planning, Urbanizing, and Zoning Board has begun to compile a cadastral map of the island, but as yet no part of the coffee area has been so mapped.

²"Most of the flatlands in Puerto Rico have always been in fairly large estates held originally under royal grants and cultivated by slaves, but the hilly interior was settled to a great extent by squatters and small farmers who carved homesteads for themselves out of the virgin forest." V.S. Clark, Porto Rico and Its Problems (Washington: The Brookings Institution, 1930), p. 196.

lence in farm operations, does not reduce materially the efficiency of farm management because the finca does not employ mechanized equipment. Two government agencies are engaged in the resettlement of small coffee farmers.¹ Under their direction the farm boundary pattern is simplified. While still employing the metes-and-bounds system boundary lines are straightened, though the final result is not always rectangular.

On the other hand, it is almost impossible to develop field boundaries that are regular, because the distribution of crops must take into consideration soils and topography, and these vary sharply within short distances.

The five farm units shown in Figure 16² are a sample of the farm-unit pattern of the coffee area. These farms are located in Mayaguez and San Sebastian municipalities in the western part of the coffee area.

Farm unit Number 1, of 32 cuerdas of coffee and 55 cuerdas of sugar cane, or a total of 87 cuerdas, has coffee growing on the steeper slopes of the valley. Field boundaries closely follow the drainage pattern. The cane is grown on the upper slopes and a large part of the cane land is situated adjacent to the highway to facilitate transportation, a major item in the cost of harvesting cane. Note that the farm buildings lie beside the road.

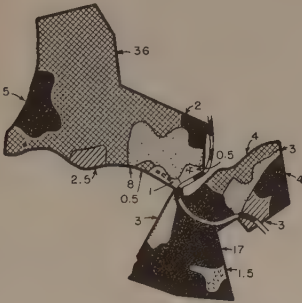
Farm unit Number 2 has 10 cuerdas of coffee, 15 cuerdas of sugar cane, 14 cuerdas of pasture, and 2 cuerdas of hay, totaling 41 cuerdas. This sample represents about the size of the average coffee farm. Access to the road, along which the farm buildings are located, has been accomplished by securing a narrow neck of land leading from the main part of the farm to the highway. The boundaries of this farm, while eleven-sided, are formed, with one exception, by straight lines.

Farm unit Number 3 is composed of 28 cuerdas of coffee, 45 of vegetables--a total of 73 cuerdas. There is also a small

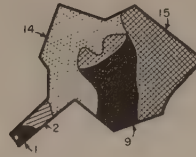
¹The Farm Security Administration and the Land Authority.

²This sample was selected from the files of the Soil Conservation Service Field Office in San Juan, Puerto Rico. The intention of the sample is to portray, in so far as possible, the variety of cropping systems that are employed on coffee farms. The acreage of the farms that are shown is larger than the average-sized coffee farm, for the reason that, in general, the owners seeking the aid of the Soil Conservation Service have the larger farms.

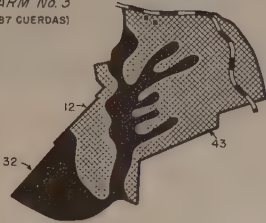
FARM No. 1
(91 CUERDAS)



FARM No. 2
(41 CUERDAS)



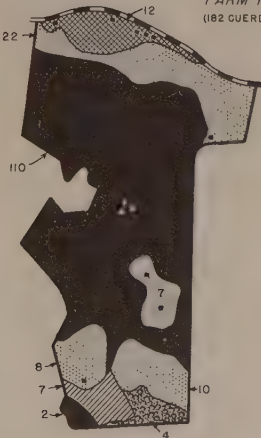
FARM No. 3
(87 CUERDAS)



FARM No. 4
(40 CUERDAS)



FARM No. 5
(182 CUERDAS)



SAMPLE LAND USE PATTERNS OF COFFEE FARMS

- Coffee
- Sugarcane
- Clean tilled crops
- Forage grasses
- Pasture
- Forest
- Road
- Farm boundary
- Field boundary
- Houses
- 7 - No. of cuerdas

0 500 1000 1500 2000 FEET

ADAPTED FROM SOIL CONSERVATION SERVICE

Fig. 16 - Sample Land Use Patterns of Coffee Farms

quarry and a small plot used for a rural school. Roads form two boundaries of this farm. Again the farm buildings are situated beside the highway. This farm is separated into three parts by the road, although operated as a single unit. In this case, also, the cane land has access to the roadway.

Farm unit Number 4 is made up of 24 cuerdas of coffee, 9 cuerdas of pasture, 3 cuerdas of vegetables, 3 cuerdas of woodland, and 1 cuerda of hay land, making a total of 40 cuerdas. A natural feature, the Rio Yaguez, forms one boundary of the farm. The farm buildings are more centrally located in the farm unit than those in any of the other samples.

Farm unit Number 5 is the largest shown in this sample. It is comprised of 112 cuerdas of coffee, 12 cuerdas of sugar cane, 47 cuerdas of pasture, 7 cuerdas of vegetables, and 4 cuerdas of woodland, totaling 182 cuerdas. The cane land and main buildings are also located beside the road, which forms one boundary of the farm. Houses of the agregados are scattered over the remainder of the farm.

In general, the larger the farm the less diversified and self-sufficient is the system of agriculture.

CHAPTER III

PRODUCTION STRUCTURE OF THE COFFEE AREA

Literature on the coffee industry of Latin America makes it clear that the structure of the Puerto Rican coffee economy is totally different, for example, from that of the coffee-producing sections of Brazil, but is similar in broad outline to that of other Central American coffee-producing countries. The purpose of this phase of the dissertation is not to compare and contrast the production aspects of the Puerto Rican industry with that of other coffee-producing countries, but rather to present a case study of the production structure of the island's coffee area. Subsequent comparisons may thus be facilitated.

Nature of Production

The method of coffee production in Puerto Rico has crystallized and remained virtually the same for the past century. Power-driven depulping machinery is more common today than in the middle of the nineteenth century, but the crops grown, the methods of cultivation, and the manner of harvesting have otherwise changed very little. After 1898 the sugar cane and tobacco phases of Puerto Rican agriculture received the stimulus of American capital and management. The efficiency in producing sugar cane and tobacco was greatly enhanced. Large investments were made to improve both the cultivation and processing phases of the sugar-cane industry. In the tobacco industry, on the other hand, foreign capital primarily entered only the processing phase, although some attention was also given toward improving cultivation methods. The coffee industry was, however, by-passed in this drama of events, and its productivity has accordingly not kept pace. The periodic hurricanes made investments in the coffee industry hazardous. As has been stated, changes in the growth and efficiency of the sugar cane and tobacco industries have, nevertheless, left their impress upon the coffee industry.

The coffee area has adapted the resources of its soil and

climate to the production of two types of agricultural crops. First, there are products grown for export to obtain "exchange" for the purchase of commodities not produced on the island. Coffee, vanilla, citron, and tomatoes fall into this category.¹ Packing centers for the last-mentioned are located in Jayuya and Villalba. These export crops yield a high monetary return per acre, a feature of the economy that is especially significant to a densely populated area, where natural resources are scant. A portion of these crops is consumed locally.

Second, products are raised for consumption on the farm and for sale over the island that yield a high return per acre in terms of food value. These crops are comprised of charcoal and a variety of vegetables and fruits (Fig. 17).

The coffee area has grown coffee for generations. Throughout its history in Puerto Rico coffee culture has been a commercial type of agriculture, with the major, as well as many of the minor crops, grown primarily for sale off the farm. Moreover, coffee is grown as the major crop in a system of multiple-crop production. Under this system, coffee, numerous varieties of bananas and plantains, and charcoal furnish about 85 per cent of the farm revenue. A few other crops may be seen in the coffee area, although not on all coffee farms. These include small patches of sugar cane, vanilla, oranges, citron, achiote, sweet potatoes, yautias, ñames, pigeon peas, cowpeas, yucca, corn, beans, mangoes, and avocados. The greatest potential revenue is not realized from the more readily perishable secondary crops, such as oranges, because of the high rate of spoilage during the peak production.² Transportation from farm to highway is slow, nor can the island market easily absorb the maximum quantity available.³ Livestock consist of oxen (for

¹A vanilla curing plant was established several years ago on the Castaner farm west of Adjuntas, where most of the island's vanilla crop is processed.

Vanilla and citron production has been especially profitable during World War II, a period when access to other producing areas was not available to the United States. The lower prices that are expected when readjustments occur in international trade will make the growing of vanilla and citron much less profitable than at present.

²The Cafeteros de Puerto Rico, located in Ponce, contemplate the construction of an orange-juice canning factory to process the surplus oranges, and thus to add to the farm income.

³It is anomalous that in Puerto Rico, where oranges are grown in abundance, in virtually no eating place on the island is

draft purposes), horses, goats, pigs, and chickens. Many farms also have apiaries to assure a high degree of pollination of the coffee trees during the blossoming period.

A greater degree of self-sufficiency is thus obtained on coffee farms than on any other type of farm in the island. However, the degree of self-sufficiency varies inversely with the size of the farm,¹ for the reason that the small farm is operated on a basis approaching self-sufficiency, while the large farm emphasizes commercial production.

Coffee farming is unmechanized, with the exception of de-pulping machinery. A tree crop grown on steep slopes is not adaptable to the use of mechanized equipment. The machete is the common agricultural tool.

Coffee farming, moreover, is a highly speculative venture in Puerto Rico because prices, and particularly yields, are highly unstable. Risk is inherent in the cultivation of a tree crop. Perennials have a life cycle during which production increases over a span of several years, holds level for a period, and then decreases until the point of diminishing returns is reached.² Prompt adjustment of acreage to price can be made with crops that are annuals. But with perennials, once the investment in planting is made, returns do not materialize for several years, and hence there is no incentive to adjust acreage to price until the life cycle of the crop is completed. Meanwhile, the owner may have to contend with violent vicissitudes in price.

Further, the coffee tree undergoes a fluctuation of yields within its productive cycle. Trees alternately "rest" and yield heavily from one year to another. This is referred to as the

it possible for a patron to obtain a glass of fresh orange juice.

¹R. Colón-Torres, "Farm Management Study of 856 Coffee Farms in Puerto Rico, 1934-1938," unpublished, to be found in the files of the Bureau of Agricultural Economics, University of Puerto Rico, Rio Piedras, Puerto Rico.

²Few coffee trees in Puerto Rico produce any berries until they are three years of age. The trees are fully productive at about seven years of age, and continue in production if given proper attention, until they are fifteen to twenty years old. If pruned during middle or old age the tree will not bear fruit for two years, but the roots, remaining vigorous, will furnish life to the new trunk and branches for another full cycle.

"health cycle." The cycle is short (two to three years) and unpredictable, and is caused by weather conditions, such as drought or high winds, and the inherent character of the plant. All coffee trees enter each phase of the cycle at the same time. Here is another reason why production cannot be adjusted to price changes.¹

Prices also fluctuate in response to demand-and-supply factors that have their origin in widely scattered parts of the world (chapter iv). Under such conditions of great risk, capital costs are high. As a result, there is a reluctance to invest capital in coffee farming, a situation that handicaps the industry.

Essential to the growing of coffee is the availability of large numbers of unskilled workers. Conditions that prevail in the coffee area meet this specification. In fact, there is a surplus of workers that may be drawn upon during most of the year. An exception occurred during the war when a labor shortage developed in some parts of the coffee area during the harvest season, because of, first, the migration of workers to war projects outside of the area; second, the drafting of young men from the area into the armed forces; and third, the competition from public works projects. In 1946, this shortage appeared temporary, for with the decline in army and navy activities and the discharge of servicemen, many persons would, in all probability, return to the coffee farms.

Some difficulty is involved in attempting to determine accurately the labor supply in the coffee area. Dependence must be placed in an interpretation of both the 1935 census and the 1940 census. Table 6 is, therefore, subject to some, but not serious, error, because of the necessity of taking data from two different years. The labor supply on coffee farms numbered about 29,176. To this must be added an undetermined number of unemployed.

The agregados constitute the largest source of labor supply. The agregado lives on the coffee finca the year round, working under a loosely arranged, generally oral, labor contract. The terms of the labor contracts vary. The worker may either be given a rent-free house, or be permitted to erect his own home. He also is allowed the privilege of planting a small garden, picking bananas and other fruits, and making charcoal to the extent of his per-

¹These fluctuations can be partially, but not completely, leveled out with the use of commercial fertilizer.

sonal needs. In return for these considerations he works for the farmer at the prevailing daily wage rates. The wage rate in the spring of 1946 varied between \$1.00 and \$1.25 per day. The farmer is, however, entitled to first call on the agregado's services. During the harvest season the agregado is paid by the almud¹ for picking coffee. If there is no work to be done on the farm, the agregado may supplement his income by working on neighboring farms, in the sugar-cane fields, or on relief projects. It should be pointed out that although the laborer on the coffee farm receives less wages than his neighbor on the sugar-cane farm, he is somewhat better off economically because he has farm privileges that provide him with a greater abundance and variety of food than is available to the cane worker.

TABLE 6

LABOR SUPPLY IN THE COFFEE AREA^a

Class of Workers	Number
Owners	11,240
Mayordomos	855
Laborers (wage workers)	15,191
Laborers (unpaid family workers)	1,890
Total.....	29,176

^aSources: Census of Population, 1940;
Census of Population, 1935.

The second source of farm labor is derived from hiring workers living off the farm. These persons are paid the going wage rate. The wage is \$0.25 to \$0.50 higher during the harvest season than during the remainder of the year. During the picking season the labor supply is supplemented by workers from the sugar-cane-producing sections along the coast who migrate to the coffee farms.

The greatest demand for labor occurs during the four-month harvest period of October to January. The low point is reached in June (Table 7). Less than half, 46 per cent of the number of persons

¹One almud equals 32 pounds of ripe berries, or the equivalent of five pounds of green coffee. During the 1945-46 crop, the prevailing wage for coffee-picking was \$0.30 per almud, and the average worker can pick from four to five almuds per day.

necessary to operate a coffee farm during the busiest month are required during the slackest month. Further, during eight months of the year the demand for labor is less than the average number required during the year. Since many women and children are employed to pick coffee it is they, and not the men, who constitute most of the unemployment during the late winter, spring, and summer months.

TABLE 7

SEASONAL FLUCTUATIONS IN THE DEMAND FOR LABOR ON 41 IDENTICAL COFFEE FARMS IN PUERTO RICO, JANUARY-DECEMBER, 1945^a

Month	Number of Persons Employed	Percentage of Average Monthly Employment	Number of <u>Cuerdas</u> Farmed per Person ^b
January.....	346	159	1.9
February.....	198	91	3.4
March.....	185	85	3.6
April.....	178	82	3.7
May.....	186	85	3.6
June.....	159	73	4.2
July.....	195	90	3.4
August.....	181	83	3.7
September.....	202	93	3.3
October.....	225	103	3.0
November.....	278	128	2.4
December.....	281	129	2.4
Monthly average...	218	100	3.0

^aSource: Unpublished compilation prepared for the writer by the Bureau of Statistics, Insular Department of Labor, San Juan, P.R., May 21, 1946. This sample study was taken each month during the week ending nearest the fifteenth of each month.

^bBased on the estimate above, of 3.0 cuerdas farmed per person per year.

To determine the intensity with which labor is used on the coffee farm, 181,106 cuerdas are taken as the number of cuerdas in coffee.¹ If 41 per cent of the coffee lands be assumed as non-bearing,² a net acreage of 96,853 cuerdas is in coffee, or land

¹U.S. Bureau of the Census, Sixteenth Census of the United States, 1940. Puerto Rico: Agriculture (Washington: Government Printing Office, 1943), p. 71.

²Colón-Torres, op. cit.

is farmed at an intensity of one person for every 3.3 cuerdas in coffee, or 0.3 persons per acre of coffee.

By comparison, among the coffee-producing countries of Latin America, Mexico, at one extreme, employs 2.5 workers per acre of coffee; Brazil uses 0.07 workers per acre of coffee.¹ Coffee production in Puerto Rico, however, ranks among the more intensively cultivated coffee-producing areas. Moreover, the wages of coffee workers in Puerto Rico are among the highest paid in any coffee-producing country in Latin America. The consequence is high unit costs of producing coffee in the island. This is especially significant to the consideration of any plans for the export of greater quantities of Puerto Rican coffee to the world market.

Puerto Rican coffee trees (coffea arabica) are grown under shade.² This shade is of two types, temporary and permanent. The temporary shade is provided by bananas and plantains that protect the small coffee seedlings.³ This type of shade is entirely satisfactory for a period of three years, at the end of which time the banana and plantain trees die. By then the permanent shade seedlings, that have meanwhile been planted, are tall enough to protect the small coffee trees. Most of the permanent shade is furnished by the guamá (inga laurina) and the guaba (inga vera). The former provides an excellent diffusion of sunlight, while the latter has a strong trunk, an asset during storms accompanied by high winds.⁴ A third tree, the moca (andira inermis) is grown to a lesser degree.⁵ The permanent shade trees reach their prime in about fif-

¹Various consular reports.

²This method of growing coffee is similar to that employed at all but the higher elevations in other coffee-producing areas of the West Indies, Central America, and northern South America. The reason lies in the fact that the variety of coffea arabica grown in these countries requires partial shade to achieve the highest yields and longest production. Coffee trees grown without shade, as in Brazil, do not, on the other hand, prosper if transplanted to these areas.

³Bananas and plantains require as much as two months' less time to mature if grown below an elevation of 1,500 feet. This is because of the higher temperatures that obtain at the lower elevations.

⁴The guamá is more commonly found at the higher elevations, and the guaba at the lower levels, although there are many plantations at all elevations growing a mixture of the two types.

⁵Orange, mango, avocado, and a few other fruit trees may also serve as shade.

teen years after which they become increasingly vulnerable to pests, especially ants. After that the trees are increasingly vulnerable to hurricanes, and hence, create the greatest damage to the coffee plantations during severe winds. Large numbers of shade trees are permitted to grow, however, until they are twenty or twenty-five years of age.

The temporary and permanent shade trees, in addition to protecting coffee from the sun's rays, have another function. They are supplementary crops. Bananas, plantains, oranges, and other fruits from shade trees are picked for farm consumption, and for sale in the city markets. When the permanent shade trees are felled they are burned for charcoal. Most of this charcoal is also sold off the farm.

Eighty-three per cent of the coffee farms are owner-operated, being owned by private individuals possessing small amounts of capital. This type of operation is in contrast to the island's sugar industry, that has large land holdings, operating, in most cases, with absentee ownership under a corporate structure. The coffee industry, being relatively unprofitable, has not attracted outside capital and has, in part, resulted in a distribution of the coffee acreage among a large number of operators. Other factors are the rugged topography of the area and the inability to adapt machinery to coffee culture.

There were 11,240 coffee farms in the island in 1935, the most recent date for which a count is available. They accounted for 466,500 cuerdas, or 21.3 per cent of all farms in the island, and 22 per cent of all land in farms (Table 8). This number was divided among approximately 5,000 different owners.¹

Coffee farming is a small-scale enterprise. While in 1935 the coffee farms averaged 41.6 cuerdas in size, 73 per cent of the farms were less than 15 acres in size (Table 9). The average size of the coffee farm is small by comparison with the sugar-cane farm that may have several hundred cuerdas in one holding, but larger than the tobacco and minor-crop farms. The demands of intensive agriculture in the production of coffee have been a factor restricting the size of coffee farms. The industry has not attracted outside capital, and the farmer has been limited to a size of farm he himself can handle most conveniently. If coffee farm practices are intensified the average size of the coffee farm is likely to de-

¹ Estimate by Cafeteros de Puerto Rico.

crease. The largest coffee farms are to be found along the eastern and southern margins of the coffee area (Fig. 18), where pastures and other crops constitute a larger share of the farm land-use complex than in the interior of the area.

Most of the coffee is produced on farms between 150 and 175 cuerdas in size.¹ Fifty-five per cent of the farm land is under cultivation (18 per cent of that is intercropped); 15 per cent is in permanent pasture; 4 per cent, in shade trees; 14 per cent, in wooded pasture; 4 per cent, in woods; 4 per cent, in buildings, roads, and fences; and 4 per cent, in waste land.²

The owner's home, the administrative center of the finca, is typically surrounded by several wooden buildings and a glacis, or concrete coffee-drying floor. The buildings are used for storage, for housing the coffee depulping-and washing-machinery, and for sheltering livestock. The large farm may, in addition, have a general store selling food and supplies, for the convenience of its workers.

TABLE 9

NUMBER OF COFFEE FARMS, BY SIZE, 1935^a

Size of Farm (cuerdas) (based on cropland)	Number	Per Cent
Total.....	9,644	100.0
Less than 3.....	1,558	16.2
3-5.....	2,659	27.6
6-9.....	1,717	17.8
10-14.....	1,094	11.3
15-19.....	468	4.9
20-34.....	829	8.6
35-49.....	399	3.5
50-99.....	514	5.3
100-199.....	290	3.0
200-499.....	156	1.6
500 and over.....	20	0.2

^aSource: Census of Puerto Rico, 1935.

¹R. Picó, "Land Tenure in the Leading Types of Farming of Puerto Rico," Economic Geography, XV (April, 1935), 140.

²Colón-Torres, op. cit.

As the calendar of agricultural practices on coffee farms indicates (Table 10), the coffee farmer is occupied in all months of the year with one phase or another of the farm's activities. The period of greatest industry occurs during the picking season. The harvesting period begins, at elevations below 1,500 feet, during September and October, or about seven months after blossoming, and continues through January. At the higher elevations harvesting commences and ends about one month later.

The berries ripen gradually, corresponding to the several blossomings in the spring. The crop is gathered in three or four pickings at intervals of about fifteen days as the berries ripen. At the last picking all remaining berries, including the unripe, are collected. The picking is done mostly by women and children. Baskets with a capacity of one almud are used. When filled they are emptied into sacks and carried to the glacis, a cement floor, to dry overnight. The following day the berries are taken to the hulling machine, or despulpadora, for the removal of the hull, or pulp. The despulpadora may be manual- or power-driven, depending upon its capacity. The coffee grains, two from each berry, drop into a bin to sweat and ferment for eight to twelve hours. This process loosens the sweet, sticky, colorless substance called baba, with which the berries are covered. During the washing process that follows, the poor grains float and are removed. The berries are then dried by again spreading out on the glacis. On some farms correderas, or shallow trays, are used (Fig. 19). The trays are mounted on rails and shoved under sheds during rains. A bombo, or heated rotating drum, found on the largest fincas, may also be used for drying the coffee. From three to five days are required to sun dry the berries. A hundred pounds of dry berries will produce 80 pounds of green coffee, inasmuch as a yellow brittle outer covering is yet to be removed. This removal may or may not be done on the farm. Green coffee, if stored carefully under proper conditions, will keep for several years, and will improve in quality with age. However, it is seldom possible to secure the proper storage conditions. Finally, coffee is put into 100-pound sacks and carried by mule or pony to market. An important feature of coffee is that the product can be broken in bulk into small packages for transport and can withstand the journey to market without deterioration.

In order to minimize the damage to coffee tree, the shade trees are thinned immediately after harvest. It is a common sight

in passing through the coffee area during the winter and early spring months, to see a plume of dense smoke rising from a coffee plantation. This originates in an earthen pit where the shade trees, cut into short lengths, are being made into charcoal. It may also be from charcoal pits on coffee land, located especially along the northern perimeter of the coffee area, that is being cleared for planting to sugar cane. In either case, the charcoal is packed into bags, and, since the product does not deteriorate in storage, may be stored for weeks awaiting higher prices before delivery to the market. Pruning the coffee trees, digging terraces, working in the nursery, planting new seedlings, fertilizing, and weeding also follow in the months after harvest. Weeding is generally done twice a year, once just before harvest in order to facilitate picking. All this work is accomplished with a machete.

Approximately 95 per cent of the coffee is produced west of a north-south line drawn through Villalba (Fig. 14), and about 93 per cent of the coffee is grown west and north of Villalba, and south of an east-west line passing through Lares.

It is difficult, as is the case with all tree crops, to ascertain accurately the distribution of yields from casual inspection. But not all of the land shown to be in coffee plantations (Fig. 14) is planted to productive coffee trees. The census¹ indicates, however, that approximately 30 per cent of the land in coffee is nonproductive.² Nonbearing coffee trees include the seedlings that have not reached maturity, inasmuch as coffee plantations must have trees of every age at all times in order to secure the maximum production year after year. Also classed as nonproductive are the mature trees whose yields are so low as to be unprofitable to harvest. The proportion of these trees to the total on the plantation varies annually with the price of coffee. Further,

¹U.S. Bureau of the Census. Census of Agriculture: 1940. Op. cit., p. 71.

²"The proportion of idle land and forested land is greater than land in coffee at elevations above 2,000 feet, but a higher proportion of the land is in coffee than is idle at elevations below 1,500 feet. This is because the winds were more destructive at the higher elevations. The proportion of idle land on the north and east slopes is greater than on the south and west slopes, because there is less protection from the [prevailing] winds on the windward sides of the hills and mountains." Soil Survey of Puerto Rico, op. cit., p. 98.



Fig. 17.--Bagged charcoal ready for shipment to the town markets.



Fig. 19.--Drying coffee on movable trays. During rains the trays can be shoved under the shed for protection. The dense growth of the coffee plantation may be seen in the background.

there are the mature trees that are totally unproductive and have been abandoned. They may have been attacked by disease or insect, have been seriously damaged by winds, have received improper care, or be located on poor soils. Finally, there are those trees so inaccessible that they are not picked. Every farm the writer has visited had some small tract of coffee land that was not harvested. In one instance, a farmer did not harvest an acreage that equaled a third of his coffee holdings. While the yields on this tract may have netted a small profit, the reason for neglect was that the owner was concentrating his attention upon increasing the yields of his most favorably situated land, and did not have the time nor labor to care for and harvest the smaller section.

On a large coffee finca sharp differences may be noted in the productivity of various tracts. Coffee production generally is much greater on the lower concave slopes than on the ridges or steep upper slopes, the vigor of growth diminishing toward the crests of the mountains. Reasons for this are, first, that erosion processes have washed the top soils from the upper slopes and deposition has taken place on the lower slopes. Thus, the fertility of the lower lands has been increased. It is on these richer soils that coffee should be planted. Second, the upper slopes are more subject to wind damage than are the lower elevations, for the latter are partially protected by surrounding hills. The above correlation between yields and position on the slopes is not universal, however, for in the higher coffee lands some of the slopes maintain their productivity to the crest of the mountains.

The finest coffees of other Latin American countries are grown above 3,000 feet. Only a small proportion of the Puerto Rican coffee area attains this height. Nevertheless, there appears to be a zone in Puerto Rico between 1,500 and 2,000 feet that marks the dividing line between the high-quality coffee grown above the zone, and the fair-quality coffee raised below the band. The section producing the finest-quality coffee is concentrated along the upper elevations of the Cordillera in the municipalities of Yauco, Ponce, and Jayuya (Fig. 21).

There appears to be no correlation between yields and elevation. Rather, yields are more closely identified with soil fertility and climatic conditions. The highest yields are obtained in the northern and eastern sections of the coffee area, where the soil is most fertile and the land least rugged (Fig. 20). Soil

erosion has not been as severe in these sections as along the steep slopes of the Cordillera. Unusually favorable conditions of climate occurring in one section of the area may increase production out of proportion to normal yields. For example, during the 1939-40 season several municipalities around the margins of the area had uncommonly high yields because of greater than average precipitation (Fig. 20).

Trends of Production

Data for the production of coffee are not available for the years prior to 1920. However, crop production may be estimated for the years between 1898 and 1920 by referring to the export figures (Table 24), and adding about 7,500,000 pounds for the estimated consumption. Thus, in 1898, coffee production in Puerto Rico was approximately 68,000,000 pounds.¹ Table 11 indicates the production between 1920 and 1947.

TABLE 11

COFFEE PRODUCTION IN PUERTO RICO, BY CROP YEARS
1920-21-1946-47^a
(in pounds)

Crop Year	Production	Crop Year	Production
1920-21...	44,194,219	1933-34...	9,000,000
1921-22...	38,367,875	1934-35...	8,000,000
1922-23...	25,271,306	1935-36...	20,000,000
1923-24...	28,908,342	1936-37...	20,536,996
1924-25...	34,177,196	1937-38...	16,639,200
1925-26...	36,334,570	1938-39...	18,949,198
1926-27...	39,124,692	1939-40...	23,498,000
1927-28...	32,393,259	1940-41...	16,200,000
1928-29...	18,446,602	1941-42...	29,593,000
1929-30...	5,351,599	1942-43...	16,959,000
1930-31...	6,000,000	1943-44...	22,231,700
1931-32...	10,090,219	1944-45...	30,094,700
1932-33...	11,381,096	1945-46...	13,796,490
		1946-47...	30,000,000 ^b

^aSources: Annual Book on Statistics of Puerto Rico, 1942-43; La Perspectiva del Cafe en Puerto Rico para el Año 1945-46.

^bEstimated.

¹By 1750 the industry was established, and by 1776 Puerto Rico was producing by weight nearly twice as much coffee as tobacco

A decrease in production of 35 per cent occurred between 1898 and 1920. For the next six years production remained fairly stable. However, the San Felipe hurricane in 1928, closely followed by the San Ciprián storm in 1932, virtually paralyzed the industry until 1935. By 1935, coffee production had recovered about 55 per cent of the average production of the period 1920 to 1928. Since 1935, production has not increased substantially, except in a few years when growing conditions were especially favorable. Furthermore, in nearly twenty years the coffee area has not been able to attain pre-1928 production levels.

The trends indicated in Table 11, together with field observations, do not leave much reason to expect that coffee production in Puerto Rico will attain pre-1928 proportions during the next several years, unless present methods of farm operations are materially improved on a wide scale. The efforts of several governmental agencies and private organizations in Puerto Rico to increase production, however commendable, can increase yields but slowly. Unusually favorable prices in the next several years would stimulate efforts to increase production, as also would several consecutive years without the occurrence of a hurricane.

Also to be noted from the long-term trend in the production of coffee is the tendency for important fluctuations to occur every other year or once every three years because of the health cycle of the coffee plant.¹

and four times as much coffee as sugar. There was a slow and steady growth for the next hundred years, and by 1850 it had grown to a figure where the exports amounted to 11,000,000 pounds. It reached 26,000,000 by 1875 prior to the first San Felipe hurricane, and then dropped to 15,000,000. By 1881, however, exports had reached 47,000,000 pounds. It reached its peak production in 1898, the Island exporting over 60,000,000 pounds of coffee just prior to the San Ciriaco hurricane of 1899.

"The hurricane of 1899 was extremely destructive, the exports dropping to 12,000,000 pounds in 1900, but the industry apparently came back and reached 50,000,000 pounds again in 1913 and 51,000,000 in 1941. Beginning in 1916 coffee exports fell off nearly 40% and reached the low figure of 16,000,000 pounds by 1923. This decline was not due to hurricanes but to other factors. The rising price of other commodities after 1916 had an influence, and during the war years growers began to plant plantains and bananas extensively in order to reap the benefit of the high prices prevailing for those particular crops." S. M. Thomson, "Puerto Rico: A Plan for the Protection of the Agriculture of Puerto Rico against Hurricanes" (Interdepartmental Committee on Puerto Rico), p. 9. (Mimeographed.)

¹"The coffee tree has its own yield cycle; it bears less

Assuming production in 1898 was 68,000,000 pounds, the acreage of coffee land in 1899 of 191,400 cuerdas, the yield per cuerda near the turn of the century was about 350 pounds. An examination of the yields per cuerda in recent years (Table 12) discloses that the average yield for the past seven years is about one-third of that nearly a half-century ago. A decrease occurred, of course, after 1928. The average in recent years of 119 pounds per cuerda compares with the estimated world average yield of 347 pounds per cuerda.¹ In the years that have followed there appears no discernible change in the long-term trend of coffee yields.²

TABLE 12

AVERAGE YIELD OF COFFEE PER CUERDA IN PUERTO
RICO FOR SELECTED CROP YEARS BETWEEN 1928
AND 1946, IN HUNDREDS OF POUNDS^a

Crop Year	Yield per <u>Cuerda</u>
1928-29	0.38
1939-40	1.33
1940-41	0.86
1941-42	1.63
1942-43	0.82
1943-44	1.23
1944-45	1.67
1945-46	0.78
Average, 1939-46.....	1.19

^aSources: Census of Agriculture, 1930; Annual crops estimate of the Bureau of Agricultural Economics, University of Puerto Rico.

The trend appears to be level. The sharp fluctuations that occur from year to year are expressions of the variations in the year-to-year productivity of the plant.

in the years immediately following a large output. When, by chance, the trees are rested and weather favorable, the crop will be unusually large; when the trees have yielded heavily the previous season and are thereby exhausted, and the rainfall is well below normal, an unusually small output will result. Characteristic variations in yields are such that the output of a particular plantation may at its high be ten times the production at its low.ⁿ V. D. Wickizer, The World Coffee Economy with special reference to Control Schemes (Stanford: Stanford University Press, 1943), p. 4.

¹Interpolated from ibid., p. 115.

²Aside from the census year 1929, no information is available on yields per cuerda prior to the 1936-37 crop.

Factors Affecting Production

Unscientific Farming Practices

Coffee production in Puerto Rico is low as judged by crop yields previously experienced in the island, and by production levels in other coffee-producing countries. The outstanding reason for this state of affairs is the almost universal use of poor farming practices. The modern Puerto Rican has not inherited a tradition of skilful and efficient agricultural techniques. Moreover, there exists among the coffee farmers a strong inertia to change. The Spanish conquistadores were preoccupied with their search for gold, and had little interest in the land for agricultural pursuits. The island had a small population in the beginning and the land was bountiful. There was no need for careful tillage of the soil. Important exceptions to this practice came only a generation or two ago with the small influx of Mallorquina and Corsican farmers who brought with them a heritage and love for efficient agriculture. The productivity of the land they farm has increased, and their cropping system is highly diversified.

The contrast of inefficient coffee culture with the more efficient sugar-cane and tobacco production is due, in part, to the fact that large amounts of outside capital have been used for the technical development of the sugar industry, while no such interest or incentive has been given the coffee industry. Sugar-cane growing has been profitable; coffee culture has not. Hurricanes that can wipe out investments in coffee farms overnight do slight damage, on the other hand, to sugar-cane fields. Sugar-cane farming enjoys a good reputation among the farmers; coffee farming is not an envied activity. Moreover, the almost continuous inability to make profits over many years has discouraged and retarded the adoption on coffee fincas of modern, scientific methods of agriculture. A contributory factor grows out of the fact that there is not the same compulsion for the coffee farmer to improve his coffee varieties to satisfy the special requirements of his market, as is the case with the tobacco farmer. As a result, relatively little attention has been given to methods of improving farming practices among the coffee farms, either by the farmers themselves, or, until recently at least, by the public agencies.

The coffee farmer may bestow the same attention upon his

poorest land as he gives to his most productive cuerdas. He prefers not to abandon his unprofitable holdings, in the hope that coffee prices will rise. Also, he knows no satisfactory substitute crop to grow on his poor coffee land, and reasons only that a little revenue, even though it is less than his expenses, is better than none.

Numerous poor farming practices can be cited. About three-fifths of the coffee trees are grown from volunteer seedlings, instead of from carefully selected seed.¹ Thus, while the cost of the coffee tree is nil, resulting yields are correspondingly low. Furthermore, coffee trees are permitted to grow so closely together without a planned geometric pattern of distribution that the root systems and branches are cramped, and unable to develop properly. The farmer has difficulty in understanding that fewer trees, well spaced, will yield more coffee.

Modern, soil conservation practices, performed properly, have been adopted on probably less than 10 per cent of the farms. Consequently, not only does soil erosion proceed at an unnecessarily high rate, but also organic matter is not given an opportunity to accumulate, and thus to restore the productivity of the depleted soil. Weeds, for example, are cut off within an inch or two of the ground, and the vegetative growth remaining offers little or no check to soil-washing. Individual terraces, where used, are commonly too small for the purpose for which they are intended, and their effectiveness is thereby greatly diminished.

The soils are low in organic matter, but the quantity of fertilizers used, either commercial or animal, is but a small fraction of the amount that could be absorbed by the coffee lands. It should be pointed out, however, that the use of fertilizer is increasing through the extension of credit for the purpose by the Cafeteros de Puerto Rico in co-operation with the Emergency Crop and Feed Loan Office. On farms using fertilizer, the method of application may be inept, because of a lack of experience in its use. Thus, the farmer may not realize the full value from his fertilizer investment. Animal manure is not available, because the system of livestock-raising is one that permits the animals to graze for food.

¹J. Guiscafne Arrillaga and L. A. Gomez, Resultado de un Estudio de las Practicas Agricolas Usadas en 398 Fincas de Cafe en Puerto Rico, Boletin 49 (Rio Piedras: Agricultural Experiment Station, 1939), p. 7.

Commonly, there is insufficient pruning of either the coffee or shade trees. Thus, the vigor and productivity of the coffee tree is partially dissipated, and the dense shade that develops does not permit adequate sunlight to reach the coffee trees.¹ Unsound shade trees are not promptly removed.

Casual experimentation and observation by farmers, and controlled experiments by trained technicians for many years, have led to substantial agreement, among the several Federal and insular agencies in Puerto Rico that are concerned with agriculture, as to what constitutes good farming practices on coffee plantations.²

Seven farming practices are essential to obtain maximum coffee yields. The application of each practice individually will result in increased production. Collectively, they provide the basis for greatly enhanced returns.

First, the planting of the Columnaris variety (Coffea arabica, L.) of coffee. This variety, imported from Java, has been shown in experiments over a number of years to outproduce the Puerto Rican, or West Indian, variety about two to one.³ The quality of the two is, for all practical purposes, the same. In 1945 it was reported that the average yield per cuerda of the Columnaris variety over the past ten years under experimental conditions was 1,170.10 pounds, and 646.69 pounds for the West Indian variety, or a superiority for the former of 81 per cent.⁴

Second, the planting of selected coffee seedlings in small nurseries, either under artificial or natural shade, followed later by a transplanting to seedbeds, and finally to the farm.

Third, the thinning of coffee trees to distances varying from 8' x 8' to 12' x 12',⁵ depending upon the size of the tree,

¹Coffee trees require diffused sunlight in an amount equal to about 50 per cent of the available light.

²A. Correa, El Cultivo de los Cafetos en Puerto Rico, Extension Bulletin No. 21 (Rio Piedras: University of Puerto Rico, 1945).

³It is estimated that there are about 50 varieties of coffee trees grown in Puerto Rico, all commonly referred to locally as the "Puerto Rican" or "West Indian" variety of the Coffea arabica species.

⁴U.S. Department of Agriculture, Report of the Federal Experiment Station in Puerto Rico, 1944 (Washington: Government Printing Office, 1945), p. 41.

⁵Eight-by-eight-foot spacing equals 661 trees per cuerda; 12'-x-12' spacing equals 294 trees per cuerda.

in order that ample space is provided for the full development of each tree's branches and root system. A triangular, quadrangular, or quincundial layout is the recommended pattern of spacing to secure the most efficient utilization of the land.

Fourth, the thinning of shade trees to distances up to 24' x 24', depending upon the size of the tree. Particular attention should be given to removing shade trees that are more than fifteen years of age, or that are dying.

Fifth, the pruning of coffee and shade trees. Two types of pruning are suggested for coffee trees, the method selected being dependent upon the age of the tree. The Costa Rican system is employed with trees varying between fifteen and twenty years of age, whose productivity is declining. The trunk is severed about five inches above the ground. New shoots soon sprout. All but two or three of the new shoots are cut off; remaining shoots form the new tree. The other pruning method is known as the Agobiada system. The young tree is bent over and staked in place until three or four vertical branches develop. The sapling is then topped. The vertical branches develop a multiple-trunk system. The production of the tree will approximately double from either of these pruning methods, and, in the case of the Costa Rican method, prolong the life of the tree, and achieve heavy production by continuing to use the mature and well developed root system. In either instance, the coffee tree will bear the second year after pruning.

The shade trees, too, require pruning to permit the penetration of adequate sunlight for the coffee trees. Pruning, in this instance, consists in removing the dead branches, and eliminating any others that interfere with the proper growth of the coffee trees.

Sixth, the adoption of several soil conservation practices. The most effective single method of combating soil erosion is through the maintenance of a short cover, about six inches in height, of grass and weeds. Run-off is thus retarded, and a high proportion of the precipitation is absorbed by the soil.

A device for increasing the humus content of the soil, in which all the coffee soils of Puerto Rico are seriously deficient, and simultaneously collecting run-off for plant moisture, is the construction, with a slight downward tilt into the hillside, of individual terraces, about three feet in radius, around the coffee

tree. The terrace, preferably to be constructed between July and December, collects the dead leaves and branches that are washed down the slope, and acts as a reservoir for the run-off. The vegetative matter decays rapidly under the temperature and moisture conditions of the tropical climate. The addition of humus will increase the availability of any commercial fertilizer that is used, and will also release the soil minerals for plant food. A device related in theory to the individual-terrace system is the construction of lateral ditches across the slopes of the finca to a depth of several inches to intercept the vegetative matter and run-off. However, ditching is not considered as effective a method as the terrace for increasing coffee yields.

Seventh, the use of commercial fertilizers. The soils of the coffee area require two kinds of commercial fertilizer. Lime is necessary to combat soil acidity. Some sections of the coffee area possess soils so high in acidity that coffee trees will not yield without an application of lime. Lime should be applied at the rate of about three or four pounds per tree. One application every five years will suffice. The application of crushed lime is economically feasible on practically all of the coffee soils.¹

The other type of commercial fertilizer is the mixture of nitrogen, phosphorus, and potash. The two analyses most commonly recommended and used are 10-10-5 and 10-6-16.² These may be applied at the rate of one to two pounds per tree, depending upon the age of the plant. The older the tree, the greater is the need for fertilizer. Satisfactory results are obtained from one application annually, made immediately after the harvest.

Topography

The mountainous topography of the area has implications affecting the production of coffee. The agricultural operations performed on the steep slopes require more labor than is necessary on level or slightly rolling land. A corollary of this is the difficulty of using mechanized equipment on these lands. Costs of production are thereby increased. Picking, for example, is slow.

¹The island does not have to rely upon foreign sources for limestone, because vast quantities are located adjacent to the coffee area. Crushed limestone can, therefore, be obtained at low cost.

²Other analyses are available in the island, but they are considered more suitable for crops other than coffee.

During the harvest season not an uncommon experience is to see a picker, high on a nearly vertical slope, clinging to a coffee tree with one hand, and picking coffee berries with the other.

Communication within the area and between areas is difficult, thus not only increasing the isolation of the coffee farmer and hindering agricultural progress, but also adding to transportation costs of all goods carried from or brought to the farm. Moreover, while the steep slopes quicken drainage and lessen leaching, they at the same time expedite erosion.

Climatic

Important climatic factors bearing on coffee production are wind storms, and variations in precipitation. The more dramatic of the two factors, and the one that most profoundly affects the yields of coffee is the hurricane. As has been noted, hurricanes have occurred in Puerto Rico on the average of once every five years during the past 287 years. Hurricanes generally occur during the months of August, September, or October, during or immediately preceding the harvest season. These storms are especially damaging to coffee farms, because the winds destroy both the shade and coffee trees of all ages. Six to seven years may be required to restore production to pre-hurricane levels.

The entire coffee area is not completely destroyed during any one hurricane. Total destruction is limited to a narrow strip that lies in the path of the storm center. For example, during the 1928 hurricane, which crossed the northern edge of the coffee area from east to west, approximately 20 per cent of the coffee area was completely destroyed. The degree of destruction decreased away from the storm center, until there was a minimum loss of about 20 per cent. Observations made immediately after the storm indicated that no slope, regardless of the direction it faces, is to be preferred for protection from wind damage. The counterclockwise movement of winds during a storm of hurricane intensity makes any slope vulnerable to damage. Added to the damage from winds is the fact that a hurricane is generally followed by a period of drought, which also has an adverse effect on the yields.

Following a storm of this type, the credit structure is disorganized, interest rates are high, costs of production and marketing are increased, yields are low, and carefully cultivated mar-

kets are lost.¹ Because hurricanes customarily occur just before or early in, the coffee harvest, the loss to the farmer is especially heavy. The owner must wait another full year before receiving any coffee crop, the largest single source of his income. If damage is heavy, several years may be required to recoup losses. Thus, the greatest single threat to the survival of the coffee industry is embodied in the hurricane.

Hurricanes cannot be prevented, but damage from them can be alleviated. The experience of the group who settled the coffee insurance claims in 1928 indicates that the better maintained the plantation, the better able it is to withstand the onslaught of the storm and more promptly afterward to recover.

Storms of hurricane force that pass close to Puerto Rico also cause damage, by blowing the leaves off the shade and coffee trees, lowering the rate of photosynthesis. Greater damage is done, however, to the shallow-rooted plantain and banana plants, for they are easily upturned. Wind storms having velocities as low as 40 miles per hour are known locally as plantaneros. They also damage coffee trees by blowing off leaves and admitting an excess of sunlight. Moreover, the added sunlight also increases the growth of grass and weeds, necessitating extra expense for additional weeding.

The second climatic factor that influences the production of coffee is drought. Extended periods of deficient rainfall, particularly if occurring during the blossoming period, will result in decreased yields. Losses from drought can be minimized through the adoption of good soil conservation practices.

Soils and Soil Erosion

The soils of the coffee area are low in fertility, owing to severe leaching of the minerals and vegetative matter from the heavy precipitation, and to the loss of surface soil through erosion. The relative productivity of the coffee soils, and the area in the island that is covered by each type, are indicated in Table 13. The infertility of the soil may be surmounted by the application of commercial fertilizers and the construction of individual

¹E. W. Zimmerman, "Staff Report to the Interdepartmental Committee on Puerto Rico" (Washington, 1940), p. 177. (Mimeographed.)

terraces, as described above. Unproductive soils increase costs of production, and, in this instance, have placed the Puerto Rican coffee industry at a disadvantage in competing with foreign coffee-producing areas.

TABLE 13

SOILS OF THE COFFEE AREA OF PUERTO RICO, BY SOIL TYPE, PRODUCTIVITY RATING, AND ACREAGE^a

Soil Type	Productivity Rating	Acres
Alonzo clay.....	95 ^b (5) ^c	17,344
Alonzo clay, smooth phase.....	95 (4)	4,992
Alonzo clay, shallow phase.....	10 (9)	2,432
Alonzo clay, colluvial phase.....	100 (4)	192
Catalina clay.....	70 (5)	38,336
Catalina clay, steep phase.....	20 (7)	58,112
Catalina clay, level phase.....	75 (4)	5,760
Catalina stony clay.....	20 (6)	11,968
Catalina stony clay, steep phase...	10 (7)	4,672
Cialitos clay.....	50 (7)	69,504
Cialitos clay, steep phase.....	50 (6)	131,840
Cialitos clay, eroded phase.....	20 (9)	8,320
Los Guineos clay.....	55 (8)	52,416
Los Guineos clay, smooth phase.....	55 (7)	18,112
Tanama stony clay.....	10 (10)	89,000
Tanama stony clay, colluvial phase.	45 (8)	9,408
Jayuya silty clay loam.....	60 (6)	4,096
Jayuya silty clay loam, steep phase	50 (7)	5,632
Total.....		532,235

^aSource: Soil Survey of Puerto Rico.

^bA production of 600 pounds of coffee per cuerda is equal to a base of 100.

^cBased on a rating of 1 to 10. A rating of 1 referring to the most productive soils, and 10 to the least productive soils.

In general, the steeper the relief, the less productive is the soil. For example, production is about four times greater on concave slopes than on convex slopes, for the reason that the soils on concave slopes, where soil movement is retarded enough for a topsoil to develop, are higher in organic matter and moisture content than those on convex slopes.¹

¹Soil Survey: Puerto Rico, *op. cit.*, pp. 183-85.

A reconnaissance erosion survey of the island¹ shows that all of the coffee area has had at least 25 per cent of the surface soil removed by erosion. The most serious erosion occurs southeast of Mayaguez, on the soils of serpentine origin. Only five small sections, all in forest, situated at the upper elevations, have no apparent accelerated erosion. Fully 60 per cent of the coffee area is classified as "severe sheet erosion; occasional gullies; more than 75 per cent of surface soil removed." The extent of this erosion has been due, to an important degree, to the steep slopes in the coffee area. Except along the northern and western periphery where the slopes vary from 15 to 40 per cent, almost all the slopes in the coffee area are over 40 per cent, and approximately one-third of the area (centered along the Cordillera) has slopes above 60 per cent.

This high degree of erosion would take on greater significance if it were not for the fact that, except for the Colinas and Soller soils, the underlying material is deeply weathered. Erosion and weathering conditions have been such that there is very little difference between the various sections of the soil profile, even to depths of several feet. Soil formation into a soil profile has not kept pace with erosion, and on only a few of the more level areas are well developed soils to be found. Under the conditions of normal coffee culture, erosion has progressed rapidly enough to keep the mantle of topsoil very thin--only an inch or two deep in many places.

While these mountain soils are not susceptible to erosion on slopes of 10 to 15 per cent, it is where the land is planted to clean-cultivated crops on the steep slopes, characteristic of the coffee area, that improper management of the surface soil has led to the greatest erosion. Soils, for the most part, are deep, and the problem of erosion, while it does not appear to be alarming, is serious, because most, if not all, of the "A" horizon has washed away removing the humus content and reducing the fertility of the soil. A new phase of the soil-erosion problem has been introduced with the extension of sugar-cane farming into sections of this mountain country. The wartime removal of the sugar-quota system gave stimulus to the growing of sugar cane on small farms.

¹Soil Conservation Service, Reconnaissance Erosion Survey of Puerto Rico (Washington: Soil Conservation Service, 1935), Scale: ca. 1:1,584,000.

Sheet erosion is more significant in the coffee area than gully erosion, for the reason that the vegetative cover of the coffee plantation retards accelerated loss of the soil. Cultivation of tilled crops on these slopes by hoe facilitates sheet erosion, particularly on slopes above 25 per cent, even where the contour method of planting without supporting structure is used. After the second or third ratoon crop from the first planting of the cane, for example, it is common to observe that the shallow topsoil, formed under the protective cover of coffee, has been entirely removed. In consequence, yields rapidly decrease, and commonly the cane is abandoned after three or four years. The land must remain idle for several years while the fertility of the soil is being restored.

Gully erosion and land slips are a common sight in the coffee area, especially on the steeper slopes, where land has been cleared of forest cover.

Many of the destroyed coffee plantations were left idle after the hurricanes of 1928 and 1932. The shade trees on the abandoned lands were cut for charcoal. These areas subsequently produced a poor grade of native grass and low brush, that have subsequently been used, if at all, for pasture. Without the protection afforded by a tree crop the gully-slip type of erosion has progressed rapidly, caused by the concentration of water into unprotected depressions, a condition that undermines the surface soil.¹

The approved methods of counteracting soil erosion on coffee land are discussed elsewhere in this chapter. Soil erosion on land cultivated to tilled crops is best combated by the use of contour planting, terracing, and strip cultivation, although no known technique has proved successful on slopes having a gradient of more than 60 per cent.

Land Tenure

Coffee production is greatly influenced by the type of land tenure under which the coffee farm is managed. Constant and close supervision is required for such farming operations as the thinning

¹D. P. Powell, "Soils and Erosion in the Coffee Producing Section of Puerto Rico" (Report in the files of the Soil Conservation Service, San Juan, Puerto Rico, 1942).

of coffee and shade trees, making of charcoal, weeding, and harvesting of coffee and fruits. Fertilizing, terracing, pruning, and caring for seedbeds are also essential if the farm is to be efficiently operated. The finca employing all operations is the most productive. The most satisfactory results are, therefore, achieved on farms that are owner-operated.

In 1939, 82.8 per cent of the coffee farms were owner-operated, and 17.2 per cent were absentee-operated. Especially significant, however, is that the latter group included many large farms (Fig. 18). A growing tendency among coffee-farm owners toward absentee ownership, implying lower coffee production, is distressing Puerto Rican agricultural leaders. At least four factors appear responsible for the trend toward absentee ownership. First, there is the tendency in Puerto Rico, as in the United States and elsewhere, of a farm-to-city movement, impelled, in part, by the preference by rural peoples for the variety of social activity available in the city. Second, the coffee farmer envies the ease with which the sugar-cane grower is able to plant and harvest his crop, and also, in many cases, to live in the city during most of the year. Third, profits from coffee farms are so small that many owners prefer to work in the cities, and allow the farm revenue to supplement their income. Fourth, coffee yields decreased to such an extent following the 1928 and 1932 hurricanes that many coffee farmers abandoned their farms to the mortgage holders and moved to the city. The mortgage holders became the absentee owners.

Table 14 represents the various classes of land tenure in the coffee area, and the number, acreage, and value of the farms thus included. No recent information is available that would indicate the impact of the war years on the system of land tenure. Table 15 discloses that while coffee farms operated by owners and tenants are approximately of the same size, the average size of the farms operated by managers is between three and four times that of the owner-operated or tenant-operated farms. For the reasons given above, the manager-operated farms, though the largest in size among the various classes of tenure, are not farmed as intensively nor as productively as the smaller holdings.

TABLE 15

AVERAGE SIZE OF COFFEE FARMS
BY TENURE, 1935^a

Tenure	<u>Cuerdas</u>
All farms	41.6
Owners	35.1
Managers	120.0
Tenants	33.3

^aSource: Population and
Agricultural Census of Puerto
Rico, 1935.

Mortgage Indebtedness

The extent to which coffee farms are mortgaged has a bearing on the amount of coffee produced. The greater the mortgage indebtedness, and therefore, the fixed operating costs, the less fluid capital the farmer has available to operate his farm. If his financial resources are meager, the farmer is unable to make adequate expenditures for the proper operation of his farm. During the 1930's, after the hurricane damage of 1928 and 1932, and the low prices that prevailed for coffee, the mortgage indebtedness of the coffee farmer became so burdensome that it was a serious handicap to the economic recovery of the coffee industry. As late as 1940 it was said that the average mortgage debt exceeded the market value of the farms.

A study¹ of the mortgage indebtedness situation among the coffee farmers made in 1935 indicates that in that year the hurricane relief loans, made from Federal funds by the Hurricane Relief Commission, secured by first or second mortgages, were \$4,910,797 on 2,662 of the larger coffee farms involving 122,000 cuerdas of coffee. Loans of the Federal Land Bank of Baltimore were about \$8,000,000. Mortgages held by private individuals were estimated at not less than \$6,000,000. There was, therefore, a total mortgage indebtedness on coffee farms in 1935 of approximately \$20,000,000, or more than \$100 per cuerda of coffee, and 82 per cent of the value of the coffee farmed. This sum was so large that

¹Thomson, op. cit.

there was little likelihood of a farmer paying off his mortgage unless he obtained a four- or five-fold increase in the productivity of his farm, and that was not to be forthcoming.

Unfortunately, some of this money was loaned without adequate provision being made for its expenditure. As a consequence, some farmers used the money for personal expenses, rather than for legitimate farm expenses. The farms thus involved were not properly rehabilitated, and their production, remaining low, made the mortgages virtually worthless.

In 1935, Descartes¹ found the following mortgage situation on coffee farms from studying a 10-per-cent sample:

Number of farms studied	523
Farms with mortgages	349
Per cent of farms in debt	67
Area of the farms studied	
Total	49,714
With mortgages	39,229
Per cent with mortgages	79
Per cent of debt estimated value	
All farms	82
Farms with mortgages	102
Debt per <u>cuerda</u>	
All farms	\$42
Farms with mortgages	\$54

The intervening years have witnessed a decrease in the amount of mortgage indebtedness. In February, 1944, the Federal Land Bank of Baltimore held 1,557 loans bearing an original face value of \$4,259,000. The total unpaid balance amounted to \$3,065,000, or 72 per cent of the face value. On March 13, 1946, the Federal Land Bank had 1,620 loans secured by coffee farms, of which about 100 were expected to be delinquent after the final payments were made to the farmers by the Cafeteros de Puerto Rico, a marketing co-operative. These loans were originally granted in the sum of \$4,200,000. The unpaid balance as of July 31, 1946, was \$2,903,000, or 69 per cent of the original grants. In other words, between 1935 and 1946, coffee loans of the Federal Land Bank decreased about 63 per cent. Less than \$10,000 worth of loans were foreclosed during this period.²

¹S. L. Descartes, La Situación Hipotecaria Rural en Puerto Rico, Bulletin 42 (Rio Piedras: University of Puerto Rico, 1936).

²Consultation with Mr. S. M. Thomson of the Federal Land Bank of Baltimore.

In recent years, the Federal Land Bank has made only a few new loans to coffee farmers. This has been because most of the farms that are not now mortgaged are poor credit risks. Such farms may be poorly located, for example, at some distance from a road, resulting in higher operating costs because of the difficulty of transportation; or such farms may not have a sufficiently diversified system of farming, either because the farmer does not understand the value of crop diversification, or because the land has such rugged topography as to be unadaptable to the production of minor crops.

In June, 1946, the Hurricane Relief Commission had about \$200,000 worth of mortgages still outstanding. In the preceding 11 years \$1,000,000 were collected. The remainder, amounting to approximately \$3,700,000, were written off.¹

The amount of the coffee-farm mortgages held by private individuals at present is obscure. Presumably, the amount is no greater than in 1935, namely, about \$6,000,000. Therefore, mortgages on coffee farms totaled less than \$9,000,000 in 1946, or 45 per cent of the amount outstanding in 1935. The decrease is largely due to the freedom from hurricanes, rising prices for coffee during the past few years, and the substantial sum written off by the Hurricane Relief Commission.

Credit Facilities

The coffee farmer has access to several credit sources, namely, the Farm Credit Administration, private banks, commercial houses, private individuals, and, to its members, the Cafeteros de Puerto Rico. Numerous and diversified in type as these credit sources are, the coffee farmer is still unable to borrow all of his capital requirements at low interest rates. The shortage of credit is due to the fact that coffee farming is a risky enterprise. The greatest element of speculation lies in the hurricane, losses from which are felt for several years after occurrence. The financial hazards thus involved result in restricted quantities of available capital loaned at high interest rates. The effect is to retard progress in farm efficiency and productivity.

The services of the Farm Credit Administration are divided

¹Consultation with the Division of Territories and Insular Possessions, U.S. Department of the Interior.

among the Federal Land Bank of Baltimore, the Production Credit Administration, and the Emergency Crop and Feed Loan Office. Funds from these agencies are available for long-term loans only to the farmers whose financial position is such as to make him a good credit risk.

The Federal Land Bank of Baltimore makes two types of loans. One grants first mortgages up to 65 per cent of the normal agricultural value of the farm, including the value of insurable buildings. The maximum loaned is \$50,000 at 4 1/2 per cent interest, amortized over a 20-year period.

The Commissioner of the Agricultural Bank also lends money to buy farms or farm equipment up to \$7,500 based on 75 per cent of the normal agricultural value, including the insurable buildings, at 5 per cent interest. First mortgages are taken provided the Federal Land Bank does not have a prior mortgage, in which case a second mortgage is taken. This loan, likewise, is amortized over a period of 20 years.

The Production Credit Administration extends loans up to \$50 at 5 per cent interest to repair and construct farm buildings, to pay harvesting costs, to buy cattle, and for other agricultural purposes. Loans generally extend for no longer than a year.

The Emergency Crop and Feed Loan Office makes loans for the direct production of the crop, such as the purchase of materials, including fertilizer, but not machinery, and the payment of labor. The maximum money loaned normally is \$400, although during the war the loan limit was raised from \$400 to \$2,500. Loans are granted for a period of one year in return for a first mortgage on the crop. About 98 per cent of the coffee loans are made to members of the Cafeteros de Puerto Rico, thus virtually guaranteeing the repayment of the credit. These loans are made primarily to small farmers who have access to no other source of agricultural credit.

Private banks, commercial houses, and private individuals make both long- and short-term loans on farms and crops at interest rates varying from 6 to 12 per cent, but they may even be higher.

The Cafeteros de Puerto Rico, through the Emergency Crop and Feed Loan Office, makes fertilizer loans to its members payable at the end of three years, the length of time considered necessary to obtain full benefit from the application of fertilizer.

Income

The coffee farmer has been plagued for many years by low coffee prices and yields. His income has been so meager as to make the coffee industry, generally, a submarginal enterprise, and low income has had, in turn, the effect of retarding the development of a more healthy and profitable economy to the extent possible under existing environmental conditions. Impoverished and discouraged farmers make little effort to enhance the productivity of their land.

Accurate measurement of farm income is difficult in the coffee area.¹ Few farmers maintain careful, or, for that matter, any, account of income and expenditures, and those who do are reluctant to disclose the information. Income varies widely from farm to farm with such factors as, the cropping system; size of farm; location of farm with respect to soils, elevation, relief, precipitation, and roads; and managerial ability. Income also varies from year to year with fluctuations in rainfall, yield of the plants, and prices both of crops sold and goods purchased.

The results of two attempts made to determine the receipts and expenditures of the coffee farm and of the cost of producing coffee are available. During the period 1934-38 a total of 856 farms averaging 168 cuerdas in size (in comparison with the island-wide average of 41.6 cuerdas per coffee farm) were studied.² These fincas had an average yield of 157 pounds of coffee per cuerda and an annual farm income of \$155. The mean price of coffee at this time was \$15.01 per hundredweight. The cost of producing coffee for this period was approximately \$14.40 per hundredweight, or \$22.60 per cuerda.

In 1943 a second study revealed that the costs of production had risen between 1938 and 1943 because of the inflationary effect of the war on prices and wages.³ Production costs per

¹Other Latin American coffee-producing countries also have little information on either coffee-farm income or costs of production.

²R. Colón-Torres, op. cit.

³V. Medina, R. Colón-Torres, and J. M. Vidal, "Report of the Committee Appointed by the General Supplies Administration of Puerto Rico to Study the Actual Coffee Situation of the Island" (Rio Piedras: University of Puerto Rico, 1943), p. 7. (Mimeographed.)

hundredweight of coffee had climbed to \$29.28. The cost per cuerda of coffee was likewise \$29.28, inasmuch as that year the average yield per cuerda was 100 pounds. The price of coffee in 1943 was about \$30.00 per hundredweight.

In both the preceding studies, therefore, the net income of the farmer was shown to be distressingly small. Profit increased slightly with an increase in the size of the farm, because of the more efficient use of workers and farm animals.¹ But so long as yields continue to be small, low income will remain characteristic of coffee farms. An increase in yields would not, however, result in corresponding decrease in production costs, because to achieve greater yields additional expense is required for such items as fertilizer, pruning, thinning, harvesting, transportation, supplies, and interest on capital. Fixed production costs in coffee farming average about 75 per cent of total costs, excluding interest charges. The largest item among the variable costs is the wages paid for picking.²

Applying Rowe's ratio to Puerto Rico, we find that an increase in the production from one quintal per cuerda, as in 1943, to four and five quintals per cuerda would result in aggregate costs of 175 and 200 respectively, while the decrease in costs per quintal would be to 43 3/4 and 40 respectively. Rounding off the 1943 production costs to \$30 per quintal, a four- and five-fold increase in yields would result in a reduction of costs to \$13.125 and \$12.00 per quintal respectively. This compares with the ceiling price of \$15.50 for the "Fancy" and \$14.50 for the "Good Washed" grades of Puerto Rican coffee in the United States as of June 30, 1946, and with the average price received by the island in the export market between 1931 and 1939 of \$17.18 per quintal.³

¹Colón-Torres, op. cit.

²Wickizer refers to Rowe's observation: "... on this basis of 75 per cent of the total costs fixed, it follows that if aggregate costs of a normal crop are taken as 100, the aggregate costs of producing a crop twice as large as the normal crop will be only 125, while the aggregate costs of producing a crop half as large as the normal crop will be as much as 87 1/2. Conversely, if the cost per bag of the normal crop be taken as 100, the cost per bag of the bumper crop twice as large will be 62 1/2, while the cost per bag of the smaller crop will be 175." Wickizer, op. cit., p. 87.

³J. J. Serrallés, Jr., and M. Vélez, Jr., Price of Coffee in Puerto Rico from 1900 to 1938, Bulletin No. 54. (Rio Piedras: Agricultural Experiment Station, 1940), p. 9.

In other words, without the tariff subsidy of \$15 per cuerda on green coffee, in 1946 the farmer, under these circumstances, would have made a profit varying between \$5.50 and \$17.50 per cuerda of coffee.¹

Competition with Other Economic Activities

The production of coffee is also affected, seemingly in inverse proportion, by the competition it receives from other economic activities in the island. The threat thus embodied is a foreboding one to the welfare of the coffee economy. The character of this competition has several features. The first involves the wages paid to workers employed in competing economic activities. Wage competition has had the effect of depleting the financial resources of the farmer, that has, in turn, hindered him in improving the efficiency of his farm.

The relationship between sugar cane and tobacco on the one hand and coffee on the other hand is a case in point. As has been noted, sugar-cane and tobacco culture are more profitable enterprises than coffee farming. Also, the sugar-cane workers are unionized, while the coffee laborer is not. Accordingly, cane and tobacco laborers receive higher wages than the coffee workers. For example, during the 1945-46 season, cane workers received \$2.00 to \$2.25 per day. The laborers on a coffee finca were paid a daily wage of \$1.00 to \$1.25. The higher productivity of the sugar-cane farm is a more influential factor than unionization in causing the higher wage level. The higher wage level of the cane worker has the effect of raising the rates of pay for work done on the coffee farm. However low the wage scale of the coffee worker thus may be, the competition from other agricultural activities continually compels the coffee farmer to pay wages that do not necessarily conform to the productivity of his farm, nor to his ability to pay.

The fact that sugar-cane and tobacco production is pursued on lands immediately adjacent to and, in some sections, within the coffee area, gives a geographical proximity to the different types of farming that intensifies the wage competition between the crops.

The competition between coffee and sugar cane or tobacco would be rendered more acute if their harvest seasons coincided. Because most of the coffee is harvested by the time the cane-grinding or tobacco seasons begin, the wage competition is, however, somewhat mitigated. Coffee grown at the highest elevations, where

¹Computed as follows: \$14.50 - \$13.125 = \$1.375 x 4 quintals = \$5.50 per cuerda for the "Good Washed" grade, and \$15.50 - \$12.00 = \$3.50 x 5 quintals = \$17.50 per cuerda if the "Fancy" grade had been sold.

the last of the crop is picked during the season, is harvested in the early part of the cane-grinding period. The competition for labor between these activities is partially diminished by the relative remoteness of the higher coffee sections from the sugar-cane areas, and by the fact that Puerto Rico's best grade and highest yields of coffee are grown at these elevations, enabling the coffee picker to earn about as much as he would in the cane fields.

Another pressure to increase wages paid to the coffee workers has its origin in the competition from public works projects. On work programs, designed to alleviate unemployment, laborers are paid on a scale that closely corresponds to that paid by the sugar centrals. On occasion, public works projects, such as the construction of roads, have been undertaken in or near the coffee area coincidental with the coffee harvest season. The ill-timed program has caused certain sections of the coffee area to suffer from acute labor shortages and from the necessity of paying disproportionately high wages.

During World War II, moreover, the coffee industry had to meet the wage competition created by the demand for men by the armed services, and for military construction programs, as well as by the general inflationary effect the war had upon the prices for consumer goods.

The second broad type of competition that confronts the coffee industry stems from the difference that exists between the system of sugar-cane and coffee farming. Coffee farming, as has previously been pointed out, is an enterprise that demands a great deal of personal attention by the coffee farmer throughout most of the year. In the growing of sugar cane, on the other hand, the work in the field is concentrated into a few weeks immediately after harvest in such activities as plowing and planting, if it is a new crop, applying fertilizer and cultivating. No further work is necessary until harvest, almost a year later. Under these circumstances, the farmer prefers the relative ease associated with growing sugar cane. Contributing to this preference is the greater readiness on the part of credit institutions to advance money on a sugar-cane crop than on a coffee crop. While a hurricane will destroy a coffee crop, it will not seriously damage sugar cane.

A third feature of competition occurred during both World Wars when there developed an increased demand for locally grown foodstuffs. The shipping shortage caused a shift in the demand from

the imported rice, beans, and codfish that are staples in the diet of the Puerto Rican, to a greater consumption of island-produced fruits, vegetables, and animal products. The general inflationary effect of the war also led to higher prices for these agricultural crops. As a result, many farmers transferred their attention to the production of the more profitable crops. The coffee farmer discovered that an increase in production of these secondary products could be made without the increase in labor costs that a comparable increase in coffee production would require. This competition with coffee was continuing in the summer of 1946, contemporary with the general high price level.

Finally, the contrast between coffee and sugar-cane farming has been partially responsible for the inadequate attention coffee farmers give their farms, and, in addition, of inducing those farmers within economical reach of the sugar centrals to clear their land of coffee and plant it to sugar cane. The result has been imprudent farming practices and low yields on the coffee fincas.

Access to Transportation Facilities

Many coffee farmers live a considerable distance from the highways. Their geographical isolation adds to the transportation costs. Agricultural products grown for sale, as well as all items purchased by the farmer for his use must be slowly transported on the backs of animals over tortuous trails. Although coffee is able to withstand the rigors of poor transportation without deteriorating, fruits and vegetables perish quickly. Thus, the cultivation of minor crops for sale off the farm is discouraged. As a result, not only are operating costs increased, but the income of the coffee farmer is also kept low. The isolation of the farms in this rugged topography is a strong deterrent to the spread of knowledge about progressive agricultural techniques among the farmers.

Table 16 gives an insight into the degree of isolation of the coffee farmer. Included in this table are six municipalities that lie wholly, or in greater part, within the coffee area. For purposes of comparison, in the island as a whole, 17 per cent of the farms are located on a road; 7 per cent are situated one-half kilometer or less from a highway; 11 per cent are located more than one-half and not more than one kilometer from a road; and 65 per cent live more than one kilometer from the highway.

The situation in the coffee area, in so far as linear dis-

tance from roads is concerned, is virtually the same as for the entire island. However, because the coffee area is situated in the more mountainous section of Puerto Rico, where travel is correspondingly more difficult, the coffee farmer is more distant, in point of time, from the roads than are other Puerto Rican farmers. The deterrent to the extension of more roads in the coffee area is the high cost of highway construction across the difficult terrain. Building costs are three to four times as great in this mountainous section as in the lowlands. However, the coffee farmer will, in time, become less isolated as the insular government's program develops to build additional roads through the coffee area.

Diseases and Pests

The various diseases and pests that attack the coffee and shade trees of Puerto Rico to reduce yields are arranged in tabular form in Tables 17 and 18.

TABLE 17
COFFEE DISEASES IN PUERTO RICO^a

Disease	Environment Favorable to Development	Remedy
Root rot.	Soils rich in organic matter. Acid soils.	Application of lime to raise the Ph. to 6.5.
Rust, <u>Corticium koleroga</u> (Cook).	Humid, such as ravines and beside streams. Attacks old trees in preference to saplings.	Thin shade trees to increase circulation of air.
Rust, <u>Omphalia (Stilbella) flavida</u> , Cook Mauld. and Rangel. Span.: <u>Mancha de hierro, ojo de gallo, and viruela</u> .	Under dense shade.	Thin shade trees, and apply calcium carbonate or wood ashes to soil.
Leaf spot, <u>Cerosporo coffeicola</u> , B. et Br. Span.: <u>Mancha ojo de sapo</u> .	Under sparse shade, exposing coffee trees to wind. High humidity during rainy season especially favorable for disease.	Plant more shade trees.

^aSource: El Cultivo de los Cafetos en Puerto Rico.

TABLE 18
COFFEE PESTS IN PUERTO RICO^a

Pest	Character of Damage	Environment Favorable to Development	Remedy
<u>Leucoptera coffeella</u> , Guerin. Span.: <u>Minador de la Hoja</u> .	Partially or completely destroys the coffee leaves, lowering rate of photosynthesis. Most damaging of all coffee pests.	Places that are dry, exposed to wind, and, if humidity is low, where shade is sparse. Damage especially noticeable along roads.	Construction of windbreaks and planting of shade.
<u>Myrmelachista ramulorum</u> , Wheeler. Span: <u>Hormiguilla</u> .	This ant burrows first into old shade trees, especially the <u>guama</u> . Younger shade trees, and, later, coffee trees may be attacked.	Tracts of old shade trees.	Destroy infected trees.
<u>Lachnopus coffea</u> , Marshall. Span.: <u>La vaquita del café</u> .	Feeds on tender coffee leaves and bugs.		Must be picked by hand from tree to be destroyed.
A beetle, <u>Apate monachus fabricius</u> . Span. <u>Escarabajo taladrador del tallo</u> .	Bores into trunks and branches of coffee, orange, acacia, and flamboyant trees.		Destroy infected trees by burning.
A maggot or fly, <u>Saissetia hemisphaerica</u> , Targioni, and <u>Coccus viridis</u> , Green.	Attacks coffee trees, especially small trees, retarding growth.	Insufficient shade or inadequate protection from wind.	Controlled by certain fungii that need shade, and primarily humidity for development. Construct windbreaks, and intensify and lower height of shade. Oil sprays.

^a Source: El Cultivo de los Cafetos en Puerto Rico.

Labor Skills

Virtually all labor employed on the coffee farm is unskilled. Pruning, thinning, weeding, fertilizing, picking, and drying require no more than the machete and hoe. On a few fincas, where drying machinery is used, the added skill necessary for its operation is easily taught. Even though a coffee laborer becomes well trained in the execution of good farm practices, his work will always be that of a manual laborer using simple tools. The heavy demand for unskilled workers and the absence of any requirement for skilled laborers prevent the worker from developing any skills that might be used to advantage in other economic activities, or that could be used to improve his bargaining position on the farm.

The psychology behind the fact that the same farming practices are employed today as those used one, two, and three generations ago has deterred improvement in labor skills. Because the coffee laborer knows only poor farming practices, and is indifferent to improving his efficiency, the coffee industry has inherited a tradition that is a strong opponent for future rehabilitation. Illiteracy among the workers is high, which erects an important barrier against educating the coffee farmer and worker in greater efficiency.

Attitude of the People

The people are, of course, as important to production as land, farming techniques, or capital. Healthy, strong, intelligent, and informed persons are necessary to optimum production. The people of the coffee area, in their effort to increase production, are beset by debilitating diseases, especially of the enteritic variety. They receive improper nourishment, owing to a diet that is quantitatively inadequate, and that is qualitatively restricted largely to the starched foods. They commonly lack adequate education, and many persons are illiterate. The result is, understandably, a general physical and mental apathy among the population. Intelligent as the Puerto Rican is, he is, nevertheless, caught in the vicious circle of poor diet, poor health, low efficiency, small incomes, and, to complete the circle, poor diet. While the health of the population has improved during the past half-century, extensive progress remains to be made in human rehabilitation before the coffee area can accomplish full production.

The Impact of Governmental Policies on Production¹

Puerto Rico, being a territory of the United States, has a pattern of Federal agricultural agencies superimposed on its own governmental structure. As a consequence there are no less than fourteen important governmental agencies in Puerto Rico which participate directly in the determination of agricultural policies with respect to the various phases of the coffee economy. The seven agencies² that represent the Federal government are, with one exception, all under the jurisdiction of the United States Department of Agriculture. These organizations, created originally to meet the requirements of agriculture in the States, have adapted their respective programs to meet the special needs of Puerto Rico. There are seven, some of which are autonomous, agencies³ of the Puerto Rican government that determine insular agricultural policy. In some instances, they may rely on the Federal agencies for counsel and training of personnel, but otherwise they pursue a course independent of, though not necessarily counter to, that of the Federal government. During periods of economic crisis additional agencies may be authorized. Important as the contributions of these agencies may be to the welfare of agriculture in Puerto Rico, an assessment of this governmental structure cannot escape the conclusion that in a small island like Puerto Rico, where agriculture is not very diverse, the division of functions among so many groups has made it difficult efficiently to carry out any well conceived agricultural program.

The Federal government began to take a more active part in the agricultural affairs of the island after 1935. Large sums of money to be used in the rehabilitation of the island were first

¹For an account of the problems of government in Puerto Rico during World War II, see R. G. Tugwell, The Stricken Land (Garden City: Doubleday and Co., 1946).

²Puerto Rico Reconstruction Administration, Soil Conservation Service, Farm Security Administration, Agricultural Adjustment Administration, Federal Forest Service, Federal Experiment Station and the Federal Land Bank of Baltimore. The last of these is further subdivided into four credit agencies.

³Department of Agriculture and Commerce, Agricultural Development Company, Land Authority, Insular Forest Service, Coffee Insurance Corporation, Coffee Industry Relief Commission, and the University of Puerto Rico through its Agricultural Experiment Station and Agricultural Extension Service.

made available in that year through the Puerto Rico Reconstruction Administration, created by the Congress of the United States. Other Federal agencies were subsequently established. A few continue in operation. Others, such as the Puerto Rico Reconstruction Administration, the Hurricane Relief Commission, and the National Resources Planning Board, have greatly dwindled in importance, or have passed out of existence and their functions been conveyed to other groups. Since 1941 the insular government has devoted more energy and money than before to the agricultural problems of the island. The newly created "action" agencies are divorced from the authority of the Insular Department of Agriculture, and operate independently.

The effort of these agricultural agencies is motivated by a desire to increase the level of living of the farmer by improving, through various methods, his efficiency in the use of his land. A discussion of the effectiveness of each agency in this regard is beyond the scope of this story. However, it may be said in passing, that the Farm Security Administration, the Soil Conservation Service, the Agricultural Extension Service, and the Federal Land Bank appear, perhaps more than any of the other agencies, to have contributed most to the long-run improvement of conditions in the coffee area. In general, significant improvement has not been made in increasing the productivity of the coffee land, or raising the level of living of a rapidly expanding population. On the other hand, economic conditions would have been worse without the efforts of these groups. The greatest amount of money, time, and effort of these agencies has been devoted to the sugar-cane industry. This is perhaps to be expected, inasmuch as sugar occupies such a dominant place in the economy of the island. The coffee industry, in part because it is in bad repute, has not received the thought or attention commensurate with its position in the insular economy, and has suffered correspondingly.

One phase of insular government policy has been to subsidize coffee through the imposition, by special permission of the Congress of the United States, of an import tariff of \$0.15 and \$0.18 per pound against green and roasted coffees respectively. Special dispensation was granted in this case by the Congress of the United States because coffee is the only major crop grown in Puerto Rico that is not protected by a United States tariff. Although the insular tariff acts as an effective barrier against the importation of foreign coffees, and is a direct benefit to the

Puerto Rican coffee grower, the burden of the tariff has fallen on the public of Puerto Rico, and not upon the American public, as is the case with the island's sugar and tobacco.

In addition, at times a Federal cash subsidy has been paid for coffee exported to the United States. In this instance the cost of subsidizing the Puerto Rican coffee industry is borne by the United States taxpayer. Five cents per pound was paid for the years of 1935-36 and 1936-37, 3 cents per pound for the years 1937-38 and 1938-39, 3 cents per pound for 1939-40 and 1940-41, and 2 cents per pound for 1941-42. Also, during a portion of the 1945-46 crop year the Federal government paid a subsidy of 5 cents per pound to the coffee farmer. The purpose of these cash subsidies has been to give the farmer a price for his coffee that would be equal to or nearly equal to the island-wide average cost of producing coffee. However, because of delays in making the subsidy effective, and, in some cases, a lack of information about the program among the farmers, many persons have not obtained the benefits intended from these subsidies.

To what extent these subsidies, amounting to an average of \$3,500,000 annually, have stimulated production is difficult to ascertain. The payments have no doubt increased the total output of coffee in the island by making profitable the picking of trees that would otherwise be submarginal. But observation in the field of current production practices, and an examination of coffee production trends, open to serious question whether the adoption of improved farming methods has been stimulated, or the production of coffee per cuerda has been increased as a result of these subsidies. On the other hand subsidies have no doubt saved the coffee industry from almost total extinction and the concomitant economic and social problems that implies, and for this reason have merit.

Another aspect of governmental policy bearing on the coffee industry lies in the legislation passed by the United States Congress, that is intended to apply to a set of conditions prevailing in the states. In some cases these laws may not fit the circumstances existing in Puerto Rico. Modifications then have to be sought to make the laws more compatible with conditions of another economy.

Perhaps of greater significance is the legislation that has been passed in recent years by the Legislature of Puerto Rico. A summary of the laws pertaining to coffee currently in effect is given in Appendix II.

CHAPTER IV

MARKETING OF COFFEE

About four-fifths of Puerto Rico's coffee production normally enters the domestic market; the remainder is sold abroad. The local market is exclusively dominated by the Puerto Rican product, while in the foreign market Puerto Rico must compete with a large number of other coffee-producing countries. Although a portion of the insular crop has entered the foreign market for many years, not since the late 1920's has there been any sector of the foreign market in which Puerto Rican coffee is greatly preferred. The characteristics of the domestic and foreign markets and the methods of coffee marketing in the island are the primary interests in this chapter.

Domestic Market

Domestic consumption is estimated at approximately 150,000 quintals annually,¹ or at the rate of about 7.5 pounds per capita per year.² Although the rate of consumption in the island may be low in comparison with some other countries, coffee constitutes a staple in the diet of the Puerto Rican. The beverage is consumed at all meals. Moreover, coffee comprises the sole food at a meal, particularly at breakfast, for many persons in the island.

To meet this large demand, coffee necessarily must be distributed through marketing channels in such a manner to pervade the innermost recesses of the consumer market. The inhabitants of the urban communities, and the people living on non-coffee farms, together aggregating approximately five-sixths of the island's population, are the focus of attention for the coffee middlemen. The middlemen exclude from their consideration only the persons who

¹Estimate by the General Supplies Administration, and substantiated by Table 22.

²This compares with an average per capita consumption in the United States for the years 1935-38 of 13.5 pounds, and about 19 pounds for 1946.

live on farms on which coffee is grown. On the coffee farms the beans are roasted, crushed, and prepared in amounts necessary to satisfy the consumption requirements of the owners and their agregados.

The greatest share of the coffee that is retailed in the domestic market is sold in bulk form through the small ventorillos, or food stores, that dot the towns and the rural areas.¹ Coffee thus sold may be green or roasted.² If green, the purchaser roasts the beans over a charcoal stove to whatever extent suits the dictates of his own palate. Whether green or roasted, the coffee is bought in small quantities, commonly in an amount costing a few cents, because of the very low purchasing power of the population.

A small proportion of the coffee is retailed in one-pound packages through the larger stores located in the towns, where there are more people than in the rural areas who can afford the larger purchase. Coffee may be packaged with whole or ground beans. In the former instance, the beans are ground in the home before cooking. Selling packaged coffee under a brand name, similar to the method employed in the United States, is a recent marketing development in Puerto Rico, having been initiated within the last fifteen years.

All coffees consumed on the island are unblended. The laws of Puerto Rico forbid the adulteration of the local coffee with any imported coffees if the ensuing blend is to be sold in the island (Appendix II). Primarily, the objective of this law is to prevent the sale of foreign coffees in Puerto Rico so as to insure the largest possible local market for the island's product. This law is not unpopular because the taste of the Puerto Rican consumer is for his home-grown product.

The method of preparing coffee consumed domestically is to roast the bean until it is very dark brown in color; to grind the beans into a coarse, powdery texture; to cook the coffee until it is a concentrated brew; and to serve without milk, or, as is more commonly the case in restaurants, as café con leche. "Coffee with milk" is made up of one part coffee and several parts hot milk.

¹The volume of trade of these stores is small, thus increasing the retail price of the coffee.

²The difference in retail price between the green and roasted coffees is about 33 per cent.

The trend in the demand for coffee in the island is obscure. Assuming, however, present per capita consumption to remain constant, in twenty years, with the anticipated population increase, the coffee consumption of Puerto Rico will reach approximately 200,000 quintals annually, or equivalent to about the average island production between 1939 and 1946. In other words, coffee yields will have to be increased over the ensuing years if there is to be a surplus of coffee available for the export market.

During years past when Puerto Rico has not produced enough coffee to meet her domestic requirements, the gap has been filled in two ways. The first method has been to draw upon surplus stocks accumulated from the previous year or years; and second, to import coffee from other countries. Coffees thus purchased are largely restricted to the "mild" types, and are unblended when sold to the final consumer. A small quantity of Brazilian coffee has been imported on occasion because of its low cost. The importation of coffee was necessary to supplement the abnormally small 1942-43 and 1945-46 crops.

In 1943, 4,480 quintals were imported having a value of \$79,027.38 or 17.6 cents per pound.¹ Table 19 indicates the source, quantity, and value of coffee imported during the crop year 1945-46.

TABLE 19

COFFEE IMPORTED BY PUERTO RICO, BY COUNTRY OF ORIGIN
QUANTITY, AND VALUE, 1945-46^a

Country of Origin	Quantity (quintals)	Value (including 18-cent- per-pound duty)
Santo Domingo ^b ...	56,000	\$1,342,500.00
Haiti ^b	1,000	24,750.00
Brazil ^b	17,393	319,596.38
Subtotal.....	74,393	\$1,686,846.38
c.....	30,000	
Total.....	104,393	

^aSource: General Supplies Administration, San Juan, Puerto Rico.

^bDecember 1, 1945-May 20, 1946.

^cEstimated additional purchases, May 20-June 30, 1946.

¹General Supplies Administration. San Juan, P.R.

The largest quantity was obtained from neighboring Santo Domingo, where a variety of coffee is grown that has a flavor very similar to that grown in Puerto Rico.

Marketing Systems

Two marketing systems have developed to fill the needs of the coffee industry. The dominant attention of each is directed at the domestic market, although each also subscribes a portion of its volume of business to the foreign market during years when a coffee surplus is available. The first type of marketing organization consists of the co-operative associations, exemplified by the governmentally sponsored Cafeteros de Puerto Rico; and the second is the community of private dealers. In each case these marketing systems accommodate certain important aspects of coffee production in Puerto Rico, namely, (1) coffee is produced in small quantities on a large number of farms; (2) most farms are remote, in terms of time, from the market; (3) coffee must be graded to secure the maximum returns; (4) the supply of coffee fluctuates greatly from season to season; (5) storage facilities are essential because the bulk of the coffee is supplied in one brief period during the year, whereas the demand remains constant from month to month; and (6) the coffee farmer is in need of credit throughout most of the year.

The Cafeteros de Puerto Rico.--The Cafeteros de Puerto Rico, a producer's co-operative organized to market the coffee crop of its membership, is by far the largest co-operative coffee-marketing group in the island. The Puerto Rican legislature authorized the creation of the Cafeteros in 1925, and contributed a portion of the original capital. In addition, the Federal Land Bank of Baltimore has provided annually further operating capital to enable an initial payment to be made the farmer for his crop. Early in its career, the Cafeteros gained further strength through the assimilation of several private co-operatives that were in poor financial condition.

The primary function of the Cafeteros are the collecting, buying, grading, storing, roasting, packaging, and selling of coffee.¹ In addition, a few functions, characteristic of a consumer's co-operative, have recently been assumed. These services include

¹The coffee prepared by the Cafeteros de Puerto Rico is sold under the brand name of Café Rico.

the extension of credit, in co-operation with the Emergency Crop and Feed Loan Office of the Federal Land Bank of Baltimore, for the purchase of fertilizers;¹ the sale of food and farm supplies; and the appointment to the office staff of an extension agent, who consults with coffee farmers on farm problems in an effort to increase crop production. The benefits of these services are limited to the co-operative's membership. The Cafeteros is also considering the construction of an orange-juice-canning factory to utilize the surplus oranges grown on the coffee farms. At present this fruit goes to waste during the period of peak production for lack of a satisfactory market. Plans are afoot, moreover, to construct a fertilizer plant in order to furnish the coffee farmer with fertilizer at a lower price than he now pays.

At the time of its founding the Cafeteros handled about 20 per cent of the Puerto Rican coffee crop. The company has grown until today it accommodates approximately 40 per cent of the crop. The co-operative looks forward to a continued expansion of its membership and volume of business. Several factors conspire, however, to prevent the co-operative from handling the entire crop. In the first place, many of the farmers are compelled to sell their crop immediately after harvest to private dealers in order to secure funds to liquidate their financial obligations. The farmer may have contracted for the sale of his crop with his local store in return for credit extended during the year with which to buy food and farm supplies; or the farmer may sell to a coffee buyer, and repay his creditor with the proceeds. The Cafeteros, however, is able only to make a partial payment to the farmer at the time the crop is delivered. Secondly, a small group of large farmers operates its own co-operative. Thirdly, a few of the farmers who produce large amounts of coffee hesitate to join the co-operative out of reluctance to make accessible the records of their income. Finally, some farmers are located so far from the co-operative's local office that they find it more convenient to sell their crop to private dealers who visit the farm.

The main administrative office of the Cafeteros de Puerto Rico, together with a roasting plant and warehouse, is located in Ponce. For administrative purposes the co-operative has divided

¹Fertilizer loans are payable over a three-year period for the reason that the full benefit from the fertilizer is not obtained for three years after application.

the coffee area into nine districts (Fig. 21). Thus, suboffices that function as collection points for coffee are situated in Adjuntas, Ciales, Jayuya, Lares, Mayaguez, San Sebastian, Utuado, and Yauco, the market centers of their respective municipalities. Except for the division between the Mayaguez and Lares districts, the district boundary lines coincide exactly with the municipality limits. The method of subdividing the trading area into districts to correspond with the minor civil divisions was selected because it was precise, and because the method simplified delivery instructions to the farmer. Farmers deliver their coffee to the headquarters of the district in which their farm is located. A few farmers, more conveniently located to a district headquarters other than the one to which they have been assigned, are permitted to ignore these boundaries. The coffee is temporarily stored at the suboffices and later delivered to the main office in Ponce.¹ All coffee grown by members located in the eastern half of the island is delivered to the Ponce office. Coffee from this section accounts for only about one per cent of the total coffee handled by the Cafeteros.

At the time the coffee is delivered to the Cafeteros the farmer is given an initial payment for his crop.² Subsequent payments are made at intervals throughout the year as the coffee is roasted and sold.

All coffees are classified in Ponce into one of nine grades on the basis of size and color of the grains (Table 20).³ The color of the coffee is determined in part by the methods of picking, washing, and drying. Also important are the climatic and soil conditions under which the coffee is grown, as well as the botanical variety of the coffee tree. The finest grade of Puerto Rican coffee has a bluish-gray color and grains that are uniformly large. For the most part, this quality is grown in the eastern and southeastern sections of the coffee area at elevation of more than 1,500

¹Transportation costs average about 20 cents per 100 pounds of coffee from the farm to Ponce.

²For his 1945-46 crop the farmer was made an initial payment of \$18 per hundredweight, or, on the basis of an expected total payment of \$25 per hundredweight, an advance of about 70 per cent.

³The Minimum Wage Laws preclude hand sorting of coffee, a practice followed when coffee was sold as a luxury item in the European markets.

feet (Fig. 21). Grading is essential when the product is to be exported, and is also done for the domestic trade even in years when no surplus is available for shipment abroad.

A large warehouse in Ponce provides storage space for the beans.¹ The coffee is brought from the suboffices and held until needed for roasting. Approximately the same quantity of coffee is roasted monthly, there being little or no seasonal fluctuation in the domestic demand for coffee. The factory, placed alongside the warehouse, has a roasting capacity of 7,000 quintals per month. The plant is fully equipped with modern roasting and packaging equipment, permitting uninterrupted preparation of green coffee for market.

TABLE 20

PRICES PAID BY THE CAFETEROS DE PUERTO RICO
FOR THE 1944-45 COFFEE CROP, BY GRADES^a

Grade ^b	Price	Per Cent of Coffee Marketed
AA.....	\$26.25	11.7
A.....	26.00	37.5
B.....	25.50	19.5
C.....	25.25	25.5
D.....	24.75	3.0
Segunda A.....	24.00	1.4
Segunda B.....	23.50	0.1
Collor A.....	23.25	1.1
Collor B.....	23.00	0.2
Average paid 1944-45...	\$25.64	

^aSource: Cafeteros de Puerto Rico,
Ponce, P.R.

^bNo objective differentiation can be made between these grades. The method of grading, though expertly done, is largely subjective.

¹Coffee quality is considered by many to improve with age and storage. Under ideal storage conditions, and if not held for more than a few years, the concept may be valid. The trade in the United States, fearing, however, that storage during the humid season may have had a deleterious effect upon the bean, may put such coffee at a discount.

The greatest proportion of the co-operative's coffee is packaged, although a portion may be sold in bulk to jobbers. The coffee may be ground and packed in sealed tin containers, especially if it is ground, or the beans may be packaged in paper bags, and ground later by the consumer. All packaged coffee, however, is sold in one-pound lots under the same brand name.

The Cafeteros has proved an asset to the member coffee growers by increasing the price the farmers have received for their coffee. This has been accomplished, in part, by passing on to members the profits from all of the organization's activities. Perhaps equally important is that the co-operative, by concentrating the functions of several middlemen into one unit has been instrumental in lowering unit operating costs. For these reasons, the Cafeteros nets the farmer about two cents per pound more for his coffee than the private dealers. The co-operative has also furnished its members with several essential and long-needed services that result in higher coffee yields and income. The Cafeteros has, moreover, indirectly benefited nonmember coffee farmers by providing competition for the private dealers, and compelling them to increase their prices to the farmer.

Private dealers.¹--Several types of private middlemen are involved in the marketing of coffee (Table 21). Their collective functions are identical with those of the Cafeteros, namely, the collecting, buying, grading, storing, roasting, packaging, and selling of coffee. In addition, many of the middlemen, particularly those who are nearest the farmer in the channel of distribution, extend credit to the coffee farmer between harvests, taking a lien on the crop as collateral for the loan. While the interest rates on these loans may be high, and for the middlemen who extend credit in the form of food and supplies there may accrue a double profit, the service is unquestionably a convenience for the farmer. The risk attendant upon the occurrence of a hurricane helps to explain the high interest rates. By performing all the necessary functions from visiting the farm to purchase coffee to selling in the retail market, private dealers comprise an important element in the coffee-marketing system.

¹The writer is especially indebted to Jorge J. Serralles, Jr., of the Agricultural Extension Service, University of Puerto Rico, Rio Piedras, for material on marketing by private dealers.

TABLE 21

FUNCTION OF PRIVATE MIDDLEMEN HANDLING COFFEE

Middleman	Function
Farmer	Any grower, whether or not coffee constitutes his chief source of income.
Itinerant buyer	Commonly a truckster who buys coffee directly from farmers and resells to processors.
Store dealer	An operator of a rural or town store who takes coffee in payment for merchandise previously sold to the farmer. This dealer may be either a wholesaler or retailer of coffee.
Processor dealer	A buyer of dry or wet coffee. If wet, he dries, removes the parchment, and polishes the beans. He then wholesales the coffee locally.
Processor exporter dealer	A buyer of wet or dry coffee who performs the same function as the processor dealer, and, in addition, exports coffee. Generally he extends credit to farmers. His radius of operation is broader than the processor dealer.
Exporter dealer	A purchaser of processed coffee. His profit is gained from his possession of brands or trademarks that are well known abroad. This middleman has declined in numbers in recent years.
Roaster	The "torrefactor" performs the last processing of coffee before brewing for final consumption. He may buy the green coffee from large processor-exporter dealer. He roasts and grinds the coffee, and wholesales to grocery stores, or retails to hotels, restaurants, and consumers.
Grocery store	A store that sells mainly foodstuffs and retails roasted coffee. It may also sell green coffee.

The system of marketing through private dealers now in use developed over a period of two centuries. The number of middlemen engaged in the trade has varied with the volume of coffee production on the island. During the 1930's many were forced out of business with the decrease in coffee production. The ranks of those who specialized in the export field were severely depleted, and consequently a source of specialized knowledge and experience was

also lost.

Each buyer and processor divides his attention among several sections of the coffee area, although he may concentrate his effort among the farmers located nearest his headquarters. Middlemen from each category are distributed through and around the perimeter of the coffee area. The larger the volume of business of a private dealer, the more likely he is to have an office located in a town. For example, processor dealers number 13. One is located in Adjuntas, 2 in Aguadilla, 1 in Arecibo, 1 in Ciales, 1 in Jayuya, 3 in Mayaguez, 1 in Ponce, 2 in San Sebastian, and 1 in Yauco.

The coffee marketed through the private dealers reaches the consumer after being graded. The coffee is largely sold in bulk, but, in recent years, has also been sold in packaged form. The product may be green or roasted, whole or ground.

Foreign Market

Trade circles apply the terms "Brazils," or "strongs," and "milds" to describe coffees.¹ Neither type has a scientific definition. The basis for the differentiation is subjective and geographical. Coffees grown in Brazil are "strong"; all other coffees, irrespective of country of origin, are "mild." Puerto Rican coffees are, therefore, in the "mild" category. Among the "mild" coffees of the world the Puerto Rican bean is considered to be of high quality. The trade classifies the island product as "fancy roasters having a peculiar flavor similar to 'washed Caracas,'"² and ranking next to Santos in quality and price.

Puerto Rican coffee competes favorably in price with other "milds" in the world markets. Competitive coffees come principally from Colombia, Guatemala, Costa Rica, El Salvador, and Venezuela. In the United States market, the practice among coffee roasters is to blend the "Brazilian" coffees with from 15 to 50 per cent--depending upon the quality sought--of the "milds." In the European market, on the other hand, unblended "milds" are preferred, and

¹W. H. Ukers, Ukers' International Tea and Coffee Buyers' Guide (12th ed.; New York: The Tea and Coffee Trade Journal, 1944), p. 22.

²Ukers further describes Puerto Rican coffees as belonging "to the mild washed commercial types. Its beans are large, uniform, and stylish, ranging from a light gray blue to a dark green blue color, and making a fancy roast without quakers." Ibid., p. 65.

are largely consumed without being mixed with the Brazilian product. Puerto Rico has exported coffee, largely to Europe, since the eighteenth century. The quantity shipped abroad has varied from year to year with insular production and foreign economic conditions. Hurricanes and abnormal shipping conditions during World Wars I and II have, on occasion, reduced annual exports to negligible quantities, or even precluded shipments for brief periods.

The past fifty-odd years have witnessed a sharp decrease in the volume of coffee exported from the island (Table 22). During the five-year period from 1892 to 1896 Puerto Rico annually exported 485,000 quintals of coffee. The shipments decreased to an average of 400,000 quintals annually from 1908 to 1914; 240,000 quintals annually from 1924 to 1926; 25,000 quintals for the year 1935 to 1936; and to a net import basis for the crop year 1945 to 1946. Exports have decreased because, first, production has declined, and second, previously held markets have, for one reason or another, become more difficult to hold.

During the years of Spanish rule in Puerto Rico, the mother country was almost the sole recipient of the island's coffee exports. Spain imposed a duty equivalent to \$8.57 gold per 100 kilograms prior to October, 1898. After this date, coincident with the shift of Puerto Rico from Spanish to United States control, the tariff was increased to \$18.57 gold per 100 kilograms.¹ This act greatly diminished the quantity of Puerto Rican coffee shipped to Spain, although it is said that coffee advertised as "Puerto Rican" is still served in that country.

By the early 1920's the bulk of the island's coffee was exported to several European countries and Cuba. The basis for the European demand lay in the fact that the European market demands the unadulterated "mild" coffee almost exclusively. In Europe, the island's coffee had come, over a period of many years, to be regarded as a premium product, and was in demand by the luxury trade particularly. The product, although it reached only a small proportion of the population, commanded a high price. The Cuban trade was based on the existence of a large coffee-consuming population, producing little or no coffee of its own.

¹R. Stone, "Agriculture in Puerto Rico," Yearbook of Agriculture, 1898 (Washington: Government Printing Office, 1899), p. 514.

During the three-year period from 1924 to 1926 Cuba was the principal market for Puerto Rican coffee, accounting for approximately half of the island's foreign sales.¹ In the years that immediately followed, Cuba began a campaign to expand its domestic coffee production in an attempt to diversify the agricultural economy of the country. Today Cuba produces enough coffee to satisfy her domestic requirements and to export about 400,000 quintals annually.

For the period from 1924 to 1926 Germany was Puerto Rico's second best customer, taking 15 per cent of the island's exports. The many foreign trade restrictions imposed by Germany in the years that followed, the use of "ersatz" coffee, and World War II made this market inaccessible. During the same period Italy ranked third, that is, close behind Germany in Puerto Rico's export market. The reasons for the loss of this market are the same as those for Germany. The future demand for Puerto Rican coffee by Germany and Italy is, to say the least, obscure. In the years that immediately preceded the 1928 hurricane Spain had gradually reduced its annual purchases to about 27,000 quintals. The Spanish Civil War of the 1930's took final toll of this market. The Netherlands and France were other principal markets. Increased tariffs, quota restrictions, and World War II obstructed commerce. Czechoslovakia also has at times been a buyer of Puerto Rican coffee, the largest sales to that country in recent years having been consummated during the late 1930's.

The United States, the world's largest coffee-importing market, annually consumed approximately 13,900,000 bags, or more than 18,300,000 quintals of coffee between 1935 and 1939. This is equivalent to about 50 per cent of the world's coffee production. Consumption in the United States increased to about 20,500,000 bags or more than 27,000,000 quintals of coffee by 1945, equal to 78 per cent of the world's coffee production (Table 23).² This higher per capita consumption was the result of the great purchases made by the army and navy during the war and the higher incomes of wartime workers. By comparison, Puerto Rican coffee production is equal

¹The discussion of exports by countries is based upon an unpublished manuscript by S. L. Descartes, "Problemas de Economía Agrícola en Puerto Rico," San Juan, P.R., 1944. (Typewritten.)

²United States consumption in 1946 is estimated at approximately 20,000,000 bags, or 26,400,000 quintals of coffee.

to only 1 per cent of the total United States coffee consumption, and to about 2 per cent of the United States consumption of "mild" coffees.

Puerto Rico has, at times, sold coffee in the United States, but the American coffee market has been less profitable for the island than the European, in spite of the close economic and political ties of the island with the States. Puerto Rican coffee growers have been unable successfully to compete in the United States market, where prices before 1939 varied from 8 cents to 15 cents per pound for "mild" coffees intended for blending, but have been able to compete in Europe where they received from 20 cents to 25 cents per pound. During the 1930's, however, Puerto Rico attempted to enter the United States market with a specially prepared 100-per-cent unblended Puerto Rican coffee, intended for use as a demitasse.¹ An energetic advertising campaign was conducted on behalf of the coffee for several months. The effort did not succeed, however, because of the difficulties inherent in attempting to introduce a new, relatively expensive brand to a market where coffee is purchased largely on the basis of price, rather than of quality, and where the demand for a luxury coffee is highly restricted.² The bulk of American coffees is sold at comparatively low prices through retail outlets that carry a few brands of widely and expensively advertised coffee. The Puerto Rican product necessarily was handled by specialty stores serving a restricted clientele, to whom other brands were better known or in greater demand. The selling-costs of the Puerto Rican venture were heavy, and ate deeply into the prices realized for the coffee.

Not infrequently the statement is heard in the island that because the supply of Puerto Rican coffee made available to the United States market is so variable, and therefore undependable, the roasters in the States must buy the island's coffee at a discount. It is argued that the buyers, having developed certain blends, require a stable supply from year to year if they are to maintain the quality of their product. The truth is, however, that coffee blenders have developed their profession to such a fine art

¹This coffee was sold under the brand name, Café Rico, prepared by the Cafeteros de Puerto Rico.

²For a more complete discussion of the characteristics of consumer demand in the United States, see Wickizer, op. cit., pp. 53-63.

that they can, within limits, substitute coffee grades or vary the percentages of the several coffee grades used, without a noticeable change in the taste of the resulting blend. Therefore, attacking the variability in the supply of Puerto Rican coffee may largely be a convenient bargaining device for the roaster. In 1937 and 1938 Puerto Rican green coffee sold in the United States for the same price as "Colombian, washed." Those in the island who have had experience in marketing coffee abroad confidently believe, and the evidence lends substance to their belief, that the appearance of Puerto Rican coffee on the United States market for several successive seasons might well lead to a price higher than that paid for "Colombian, washed."

Such are the conditions encountered by Puerto Rico in selling coffee abroad. At the time of writing, 1946, Puerto Rico does not need immediately to face these problems, for the island is importing, and not exporting, coffee. The last crop was small. If the present methods of farm management continue, however, there will be years in which coffee production will exceed domestic consumption, and there will be exportable surpluses available for the world market. Favorable climatic conditions or the crest in the health cycle of the coffee trees will result in above-average yields.

Puerto Rico is interested, therefore, in the prospects for the world coffee industry as a whole. An examination of both the supply and demand-factors is in order. As regards supply, the world's exportable coffee production from 1940 to 1944 averaged 26,900,000 bags (Table 24), 57 per cent supplied by Brazil and 37 per cent furnished by the remaining Latin American coffee-producing countries. By comparison, the world's exportable coffee production between 1935 and 1939 averaged 35,000,000 bags. In other words, a decrease in world coffee production of 23.1 per cent occurred in the decade ending in 1944.

The primary cause for the decline in world production was the marked drop that occurred in Brazilian production. While this decrease was due in part to very unfavorable weather conditions, it was also the result of coffee culture having reached the limit of expansion onto easily accessible virgin soils, and the decrease in the yields of existing plantations as soil fertility declined. At present coffee prices the application of fertilizer is economically unfeasible. Moreover, Brazil had a huge surplus of coffee for many years before the war, which had a depressing effect upon

prices. Many plans were tried, to bring relief to the coffee grower. Coffee was burned, or otherwise destroyed. Other stabilization schemes were attempted. None was completely successful. Many growers were bankrupt. The war resulted in Germany and other countries being cut off from Brazilian supplies through the blockade and the reduction of available shipping space. Thus, some of the decline in Brazilian production probably resulted from this unprofitable period, when coffee lands were abandoned or put to some other use. Brazil is not expected, for several years at least, to recover her volume of production of a decade ago. Meanwhile, the absence of large coffee stocks should have a salutary effect on prices for the world's coffee growers.

It is not known, of course, how quickly other countries will expand their production to fill the deficiency created by Brazil. Jonasson¹ came to the conclusion in 1932 that there are 231 million acres of land in the world climatically suitable for the production of coffee. By contrast, 12.9 million acres were planted to coffee at that time. Forty-three per cent of the potential was in Brazil, and 20 per cent in Africa. Not all of this land will be planted to coffee. Soils may prove unadaptable in some sections. Some of the land adaptable to coffee is, and will remain, planted to other crops. Other areas are too inaccessible for economic development. Individual and public inertia will prevent other acreages from being developed. Coffee diseases will plague still other areas. Other factors will deter expansion in the planting of coffee. To replace the difference between the decline in Brazilian production and the increase in other countries since 1935, would require approximately 1,530,000 acres, or about 2,400 square miles of well-managed coffee land.² If coffee history may be used as a guide, however, the world may be poised for another period of expanded coffee plantings and production. If this proves to be the case, a significant increase in world production cannot be felt in the world coffee markets for at least five years, or until 1951, the minimum length of time required to get new plantings into heavy production.

As regards the demand factor in the world coffee markets,

¹Wickizer, op. cit., p. 107.

²Assuming a yield of 500 pounds per acre.

Wickizer points out that the demand for coffee is quite inelastic,¹ but he also goes on to show that a considerable price rise will eventually cause a decrease in consumption. World consumption between 1935 and 1939 averaged 27,600,000 bags, and 21,200,000 bags from 1940 to 1944. The decrease was due to the decline in European imports during the war. Consumption increased to approximately 26,300,000 bags in 1945, because of the increase in United States demand and the relief in the shipping crisis. It is expected that consumption will increase slightly in the immediate future as the European market is reopened.

Using generous estimates of demand and prudent estimates of supply for the next five-year period, it appears that a world shortage of coffee and high coffee prices may be maintained. If the demand does not reach expectations, and if the supply is greater than is now calculated, a small world surplus and coffee prices somewhat lower than the 1946 level might exist. First, world--and particularly United States economic--conditions, and second, weather conditions in producing countries will be the determining factors in establishing future coffee prices. Meanwhile, Puerto Rico may

¹"Because coffee drinking is generally a habit, it is common to observe that moderate changes in price produce slight responses in consumption. The demand for coffee is thus considered quite inelastic. This is largely true of consumer demand, especially over short periods, because habits are not quickly changed. It is less true of the responsiveness of trade demand over short periods. The demand of the trade for raw coffee over longer periods must, of course, reflect consumer demand for the beverage.

"While consumer demand for roasted coffee is fairly stable and comparatively inelastic in respect to price, the commercial demand for raw coffee is not; indeed the international movement of the raw product is quite responsive to price changes. This means in part that the trade tends to build up imported stocks in periods of low price and to reduce them when prices are high. But it also means that an abundance and low prices stimulate the trade to embark on campaigns not merely to dispose of large stocks but to raise the level of public demand.

"It is interesting to note that sharp reductions in per capita national income during the 1920-21 depression, and later in the great depression of the 1930's, apparently did not result in much reduction in coffee consumption. This might be expected in the short depression of the early 1920's because a readjustment of coffee-drinking habits does not take place quickly; yet it seems probable that if coffee prices had not fallen in the 1930's enough to compensate for reduced purchasing power, some lowering of the coffee consumption level would have occurred at least early in the decade. On the other hand, high or rising national income seems to have had little stimulating influence in the late 1920's in the absence of "favorable" retail coffee prices." Wickizer, *op. cit.*, pp. 41-48, 50-51.

reasonably expect the best market for its exported coffee in nearly a generation.

The appraisal of the long-run prospects, that is, for the period after 1951, for coffee is exceedingly difficult, because of the numerous imponderables influencing supply and demand. Also, one cannot disregard the shifts that may occur, as they have in the past, in the demand for the several beverages. Suffice it to say that, on the basis of past performance, the world coffee trade may reasonably expect a repetition of coffee surplus years.

The outlook for world supply and demand for coffee is such that Puerto Rico should expect for the next five years to sell any surplus production abroad at prices substantially higher than those that prevailed during the 1930's.¹ The price structure after 1951 must remain obscure.

¹During the 1920's the average annual price of Santos No.4 coffee, the grade that serves as a price standard in the trade, in New York was 19.1 cents per pound, varying from a high of 24.5 cents in 1925 to a low of 10.4 cents in 1921. During the 1930's the average price was 9.8 cents per pound, with a high of 11.2 cents in 1934 and a low of 7.5 cents in 1939. The ceiling price in the United States in 1946 was established at 15 cents per pound.

CHAPTER V

TOWARD A SOLUTION OF THE INDUSTRY'S PROBLEMS

Findings

As has been stated, agriculture is the most important single element in the economy of Puerto Rico. Almost the entire population of two million persons gains its livelihood, either directly or indirectly, from farming. The several phases of the island's agricultural activity are distributed regionally, each with a specific topographic-pedologic-climatic complex.

Like all farming areas, the coffee area of the island has its land-use problems. The difficulties encountered in the coffee economy of the island are deep-rooted and long enduring. Several are common to all of the agricultural areas of Puerto Rico. Others are peculiar only to the coffee area. Some are inherent in the physical environment. A few are the result of man's trespass upon nature's design. Most can be alleviated, at least partially.

This study of the coffee industry of Puerto Rico has disclosed the following findings. Some are fundamental facts, some are well established relationships, and some are concepts of what will be necessary if the problems of the coffee area are to advance toward solution.

1. The setting is in the west central highlands where the coffee area, a cohesive type-of-farming unit producing 95 per cent of Puerto Rico's coffee crop, covers 935 square miles, or an area extending over about a third of the island.

2. The area is homogeneous with respect to its topography land-use complex, parent material forming the soils, climate, and agricultural problems. Wide variations from the norm in each of these respects are, however, to be seen under microgeographical examination, because of abrupt differences in slope and climate within short distances.

3. The highly dissected Cordillera, rising to 4,000 feet, forms a massive, sharply dissected mountainous backbone extending in an east-west direction close to the southern limits of the area. The terrain becomes less rugged, and decreases in elevation toward

the north.

4. Drainage is patterned dendritically, with many of the innumerable, constantly flowing freshets and streams cascading down the mountain slopes to the westward- and northward-flowing rivers, such as the Añasco, Culebrina, and Arecibo. Several excellent dam sites for hydroelectric power plants occur along the rivers.

5. The tropical rain forest that covered much of the island at the time of its discovery has succumbed to the demands for agricultural land, and in its place are the coffee plantations and the grass and brush pastures.

6. Red and yellow podsols comprise the great soil group covering the area. These soils, largely derived from fine-grained volcanic rocks, are lateritic, acid, and well drained. Like most tropical areas they are leached of mineral content and depleted of organic matter, and, therefore, are generally low in fertility.

7. The tropical wet-and-dry type of climate is characteristic of the area. The average annual temperature varies from 68° along the Cordillera to 76° at the outer margins of the area. Average monthly temperatures vary during the year over a range of from 5° to 8° , with a march that is typically maritime. The annual precipitation varies between 85 inches in the north and east, and over 105 inches at Maricao in the west, with the period of least precipitation occurring between December and March, and the maximum in July. Over a period of nearly three centuries a hurricane has struck the island on an average of once every five and one-half years, although the full force of these storms has not been felt in the coffee area each time.

8. Travel between towns is channeled along macadamized mountain roads, while intra- and inter-farm communication is by way of narrow, dirt roads, and a maze of winding footpaths.

9. The population is a mixture of the descendants of Spanish immigrants, African slaves, immigrants from Central America, and, to a minor degree, the Arawaks and Caribs who were on the island at the time of discovery.

10. Some 310,000 persons lived in the coffee area in 1939 at a density of 347 persons per square mile and 610 persons per square mile of arable land. The population of the area is increasing at the rate of about 8,000 persons per year. These densities are somewhat lower than for the rest of the island, because of the lower demand for labor per acre of coffee than for most of the

other crops in the island; the small urban population of the area; the migration of the population to other parts of the island in search of alternative types of employment, or for the enjoyment of the city's social life. The area is one of the most densely populated agricultural regions in the world.

11. The population, 88 per cent rural, is rather evenly distributed throughout the area. Dotting the rural landscape are the homes of agregados, perched on hilltops or clinging to the steep slopes. The scattered segments of sparse settlement in the area denote a physical environment unharmonious with agricultural land-use. There are ten compactly built village communities, ranging in size from 391 to 4,302 inhabitants. Each town is the political and market center for its respective municipio.

12. Approximately 86,000 persons, male and female, are employed in the coffee area. About 60 per cent of them work on farms. The remainder has employment indirectly related to agriculture.

13. The coffee area makes several important crop contributions to the remainder of Puerto Rico. First, the island's coffee requirements are supplied by the coffee area, except for an occasional year of very poor harvests. Second, coffee is adaptable to rugged terrain, and on farms around the perimeter of the area, that have another crop as their major emphasis, coffee is grown on the steep land that otherwise could not be used profitably. Third, a wide variety of farm products is grown in surplus quantities as an adjunct of coffee farming. Chickens, goats, pigs, charcoal, and especially a wide variety of fruits and vegetables are thus made available to the rest of the island.

14. Because of variations in price and yields from year to year, the income annually contributed by the coffee area to the insular economy is difficult to ascertain accurately. In 1939, the value of coffee was equal to about \$2,750,000 annually, or about 5.5 per cent of the island's direct income from agriculture. In addition, about 4.5 per cent of the island's income is obtained from the coffee area's contribution of livestock, fruits, vegetables, and charcoal. The total contribution, therefore, was about \$5,000,000.

15. Labor contributions of the coffee area are, first, a seasonal and temporary migration of labor from the coffee area to the cane fields, commencing in January at the end of the coffee

harvest and at the beginning of the cane-grinding season, and extending into June; and second, a permanent emigration to other agricultural areas and to towns that has occurred with the decline in the fortunes of the coffee area. World War II, bringing with it the construction of military installations outside the area and conscription, accelerated this movement. In each case the mobility of labor is facilitated by the network of good roads and the small size of the island.

16. The boundaries of the coffee area, forming an irregular design that expresses an adjustment to the physical factors of topography, soil, elevation, rainfall, and to the economic factor of competition with other crops, have remained virtually static since 1932. In fact, these boundaries have shifted very little since the turn of the century.

17. The northern boundary lies along the foot of an escarpment, north of which the soils, of limestone origin, are more profitably utilized when planted to sugar cane than to coffee.

18. The position of eastern boundary is related to four natural conditions, namely, (1) topography, for east of this line the hills are more rolling than to the west, and thus more suited to cultivated crops; (2) rainfall, as a decrease in precipitation, below the amount necessary for good-quality coffee, occurs to the east of the boundary; (3) hurricanes, in that damage from hurricanes was especially heavy along this sector in 1928 and 1932 (following the storms many of the coffee plantations were cleared and the land planted to minor crops or used for pasture); and (4) soils, as east of this boundary the soils are of lighter texture than those to the west, and are more adaptable to the growing of minor crops.

19. The southern boundary follows along the south base of the Cordillera Central and also is closely adjusted to natural conditions. Decreasing rainfall on the lower slopes in the lee of the mountains, and competition from sugar cane grown on the foothills of the Cordillera Central establish the line of the southern boundary between Villalba and Yauco. West of Yauco is an expanse of serpentine soils on which coffee does not thrive. These soils, therefore, mark a portion of the southern boundary.

20. The western boundary meanders widely. The bases for this line of demarcation lie in the factors of soil, relief, climate, and competitive types of land use. Temperatures in the low-

lands to the west are too low for good-quality coffee. Between Añasco and Moca the boundary represents an adjustment to climate and soils for the rainfall decreases to the west and the soils become thin and infertile, and the land can be used only for pasture and subsistence crops.

21. The coffee area, with two important exceptions, is densely covered with bearing and non-bearing coffee trees. The first exception is a section about 50 square miles in size, surrounding Jayuya and Utuado. This section has light-textured granitic soils suited to the growing of tobacco. The second exception consists of the several segments of governmentally owned forest land spread along the upper reaches of the Cordillera. The soils of these holdings are too thin and depleted to produce satisfactory yields of coffee. Other sections of the coffee area, where coffee plantings are relatively sparse, indicate either soils that are inferior for coffee production, or soils and topography that are more adaptable to sugar cane than to coffee. Coffee plantings reach their maximum density along the Cordillera between Mayaguez and Adjuntas.

22. The land-use patterns of the coffee area have been crystallized for more than a generation. However, the execution of the contemplated road-building program may alter the pattern by encouraging the substitutions of sugar cane for coffee on lands within one kilometer of the highway, the distance that would allow the economical transportation of cane.

23. Farm boundaries, described by the metes-and-bounds system, are without order, following roads, ridges, valleys, streams, or completely ignoring physical and cultural features. This jigsaw pattern, developed over four centuries, does not seriously interfere with the efficiency of farm operations because the finca is not mechanized.

24. Field boundaries are irregular. Lines dividing fields adjust, in part, to the physical factors of soils and relief.

25. The methods of coffee production have remained virtually the same for the past century, whereas the sugar-cane and tobacco economies have experienced striking advances because of the entrance of American capital and management.

26. The coffee area produces two types of crops; first, products high in monetary value destined largely as cash crops in order to obtain food and manufactured products; and second, crops

high in food value intended for consumption largely within the area.

27. Coffee culture is a commercial type of agriculture. Moreover, coffee is the major crop in a system of multiple-crop production. Coffee, bananas, plantains, and charcoal, in that order, furnish about 85 per cent of the farm revenue. The remainder is divided among oranges, vanilla, citron, other tropical fruits and vegetables, goats, pigs, and chickens.

28. A greater degree of self-sufficiency is obtained on coffee farms than on any other type of farm in the island. The degree of self-sufficiency decreases with an increase in the size of the farm.

29. Coffee farming is a highly speculative venture, because yields and prices are unstable. Yields are unstable because of the "health" cycle of the plant that causes high yields one year and, a year or two later, a crop of low yields. Prices fluctuate above the tariff level with demand and supply-factors having their origin in widely scattered parts of the world.

30. Coffee farms require large numbers of unskilled workers, especially during the picking season. The greatest demand for labor occurs between October and January during the picking season. This labor is provided by agregados living year-round on the farm, and supplemented by hired workers living off the farm. About twice as many persons are employed at that time on coffee farms as in June, the month of lowest demand for labor. Coffee farms are operated at a year-round intensity of 0.3 persons per acre of coffee, a density that is among the highest of the coffee-producing countries of Latin America.

31. Coffee culture employs two types of shade trees, temporary and permanent, to protect the coffee trees from the direct rays of the sun. The temporary shade, consisting of plantain and banana trees, is used to nurse the young coffee plants for three years. The permanent shade is furnished largely by the guamá, guaba, and, to a lesser degree, moca. These reach their prime in 15 years, but may not be cut for another several years. When cut the trees are burned to make charcoal.

32. Eighty-three per cent of the coffee farms are owned and operated by private individuals possessing small amounts of capital. The relative unprofitableness of coffee culture, rugged topography, and the inability to adapt machinery to coffee culture have not attracted outside capital to the industry.

33. In 1935, there were 11,240 coffee farms, or one-fifth of all farms on the island. They averaged 41.6 cuerdas in size, although 73 per cent of the total number of coffee farms were, however, less than 15 cuerdas in size, and were divided among approximately 5,000 different owners.

34. The harvesting period commences at the lower elevations in September, about seven months after blossoming, and progresses into higher elevations, until the last coffee is picked near the end of January. Most of the coffee is depulped with machinery and sun-dried on the farm.

35. Other farm operations, such as thinning, pruning, digging terraces, planting, fertilizing, and weeding of coffee, and tending to other crops, occupy the farmers' time throughout the year.

36. Approximately 30 per cent of the land planted to coffee is nonproductive. Non-bearing coffee trees include seedlings that have not reached maturity; mature trees whose yields are so low as not to warrant picking, and whose number varies with the price of coffee; old trees that are totally unproductive; and trees so inaccessible that they are not picked.

37. Sharp differences in the productivity of the land may be noted within short distances. Coffee yields generally are much higher on the lower concave slopes, onto which soil has been washed, and where the trees are partially protected from the wind, than on the ridges or steep upper slopes.

38. A zone lying between the 1,500- and 2,000-foot contours marks the dividing line between the high-quality coffee grown above the zone and the fair-quality coffee grown below the band. The finest-quality coffees are produced along the upper elevations of the Cordillera in the municipalities of Jayuya, Ponce, and Yauco. However, there appears to be no correlation between yields and elevation.

39. Average production of coffee between 1935 and 1946 was 21,500,000 pounds, or about 60 per cent of the 1920-28 average island production. Recent production trends, together with field observations, indicate little reason for believing that pre-1928 production levels will be attained in the next several years unless a concerted effort is made among coffee farmers to improve their farming practices. The average yield for the period 1939-46 was 119 pounds per cuerda, as compared with 350 pounds per cuerda near

the turn of the century, and the estimated world average of 347 pounds per cuerva. While the yields fluctuate from year to year, the trend in yields since 1939 has been level.

40. Coffee production is low as judged by crop yields previously experienced in the island, and by production levels in other coffee-producing countries. The outstanding reason for this is the almost universal use of poor farming practices. Such practices include the use of volunteer seedlings, the growth of coffee and shade trees so close together as to produce a chaotic pattern, the cutting of weeds too close to the ground and thus facilitating erosion, the failure to adopt other soil-conservation practices, the insufficient pruning of coffee and shade trees, and, finally, the nonuse of fertilizers. All this in spite of the fact that there is substantial agreement among the agricultural agencies as to what constitutes good farming practices.

41. Two climatic factors adversely affect coffee production. The hurricane embodies the most serious threat to the coffee industry. Experience indicates, however, that the better maintained the coffee plantation, the better able it is to withstand the onslaught of a storm. Drought, particularly if occurring during the blossoming period, will also decrease yields.

42. Soil erosion has seriously depleted the soils of organic and mineral matter. At least 25 per cent of the surface soil has been removed from the entire area, and 60 per cent of the area has had more than 75 per cent of the surface soil removed. This high degree of erosion would assume greater significance if it were not for the fact that the underlying material is deeply weathered and soil development is accordingly rapid.

43. Coffee production is affected by the type of land tenure under which the farm is operated. Constant and close supervision of all farming operations is essential to high productivity, and hence, the most satisfactory results are achieved on owner-operated farms. It is especially significant, however, that the latter group included many large farms.

44. Coffee-farm mortgages have been reduced from about \$20,000,000 in 1935 to approximately \$9,000,000, or \$50 per cuerva, in 1946. This resulted from the fact that a substantial amount was written off by mortgage holders and the further fact that rising coffee prices and freedom from hurricanes characterized the period. Significant as this decrease may be, mortgages are equal

to approximately half the land value and remain a heavy burden for farms that are marginal and submarginal.

45. The coffee farmer has access to several public and private credit sources. Numerous and diverse as these sources are, the coffee farmer still is unable to borrow all of his capital requirements at low interest rates, because of the large element of risk inherent in coffee farming.

46. The income from coffee farms has been so low for many years as to make the industry generally a submarginal enterprise. Low income, in turn, has retarded the development of a more healthy and profitable economy. So long as yields remain small, low income will continue to be characteristic of the coffee farm. However, an increase in yields will not result in a corresponding decrease in production costs. Fixed and variable costs of producing coffee are 75 per cent and 25 per cent respectively, of total costs. An increase in production from one quintal to four quintals per cuerda will result in total costs of 175, while the decrease in costs per quintal will be to 43 3/4. In other words, present costs of about \$30 per quintal would be reduced to \$13.125.

47. The production of coffee also is affected, seemingly in inverse proportion, by the competition it receives from other economic activities. First, the wages paid in other activities on the island, such as cane and tobacco fields, relief projects, and defense activities, are higher than those of the coffee farm. The result is a constant pressure to increase coffee-farm wages to the extent that they may not conform to the productivity of the farm. Second, the relatively little attention necessary to produce sugar cane and the higher monetary returns make that crop a preferred method of land use, at the expense of coffee, wherever cane can be grown. Third, during the war, the shipping shortage created a large demand for locally grown foodstuffs at high prices, with the result that the coffee farmer raised larger quantities of food and gave less of his attention to coffee.

48. By virtue of the rugged topography, the coffee farmer is more isolated than the farmer of any other part of the island. This is translated to high transportation costs and a depletion of income with which to increase farm production.

49. A number of diseases and pests, of which root rot and minador, an insect pest, are the most destructive, attack both coffee and shade trees and thereby reduce yields.

50. Governmental agricultural policy for the coffee industry is largely determined by seven Federal agricultural agencies, all but one under the U.S. Department of Agriculture; seven insular agricultural agencies, some of which are autonomous; the Legislature of Puerto Rico; and, indirectly, by the Congress of the United States. The division of functions among so many groups has made it difficult efficiently to carry out any well conceived agricultural program. In general, significant improvement has not been made in increasing the productivity of the coffee land, nor raising the level of living of a rapidly growing population. On the other hand, economic conditions would have been worse without the efforts of these groups. Probably the greatest benefit to the coffee farmer has accrued from the insular tariff, amounting to 15 cents and 18 cents per pound on green and roasted coffees respectively.

51. Any marketing system for coffee in Puerto Rico must be in harmony with certain basic considerations, namely, that coffee is produced in small quantities on a large number of farms, that it must be graded to secure the maximum returns, that the supply of coffee fluctuates greatly from year to year, that storage facilities are essential because of the seasonality of the supply and constant demand for the coffee, that the farmer is in need of credit throughout the year, and that coffee can withstand rough handling without deterioration while being transported.

52. Coffee is marketed by the Cafeteros de Puerto Rico, a producer-consumer co-operative, and by private dealers, handling about 40 per cent and 60 per cent respectively, of the total crop. Competition between the two groups has led to higher coffee prices for the farmer.

53. The island produces a high-quality, "mild" coffee, yet during the past 55 years coffee exports have decreased from 485,000 hundredweight in 1891 to an import basis in 1946. This has resulted from (1) decreased production, owing to hurricanes and low prices; (2) difficulty in selling to previously held markets because of trade restrictions imposed by foreign countries; and (3) relatively high costs of production as compared with other coffee-producing countries.

54. Puerto Rico has been unable to capture a special place in the United States market. The wide irregularity from year to year in the supply of Puerto Rican coffee led the United States

roasters to purchase the product at a discount. Regularity of supply might correct this disadvantage. An attempt to enter the United States market with a special brand of coffee during the 1930's met with little success because the island offered an unblended coffee, intended for the luxury trade, at a price substantially higher than the popular priced brands. The results were disappointing. The demand was small, and probably the movement did not have sufficient financial and other backing to get results.

55. The world supply of coffee currently is approximately equal to the demand, and this balance is expected to be maintained for a minimum of five years. The decrease in supply is largely the result of the decline in Brazilian production, owing to the depletion of coffee soils, the exhaustion of the supply of easily accessible virgin soils, and two decades of coffee surpluses and concomitant unprofitable prices. Coffee prices are expected to maintain a relatively high level until 1951. In the long run, as new coffee lands are put into production, there may again be a world surplus of coffee, and a subsequent decrease in coffee prices.

56. Domestic consumption is about 150,000 hundredweight annually in Puerto Rico, or at the rate of about 7.5 pounds per person. Assuming current per capita consumption to remain constant, domestic consumption will reach about 200,000 hundredweight by 1960, or approximately the average island production between 1939 and 1946, if the present rate of population growth remains the same. During deficit producing years, coffee is purchased from neighboring Central American countries, notably Santo Domingo.

Bases for a Land Policy

Puerto Rican coffee is a "mild" variety, comparable in quality with the best grades of the Central American coffees. The coffee area, largely by virtue of its mountainous topography, depleted soils, inefficient farming practices, and relatively high wages, is unable, however, to produce coffee as cheaply as it can be grown in competitive areas, where land is less rugged, more fertile, more plentiful, and where labor costs are lower. Available evidence indicates that, if Puerto Rico's coffee industry is to survive, the continued maintenance of large subsidies will be necessary, especially as long as present methods of farm operation are not improved. Whether or not coffee cultivation, submarginal

and subject periodically to severe damage from hurricanes as it is, should be further encouraged as a method of land use, is the fundamental problem seeking solution.

The coffee lands have, as has been stated, poor soils, and are difficult to manage because of the broken terrain. The same type of land in the United States, where lands more suitable to cultivation are available, would probably be converted to forest and recreational uses. However, with a rapidly growing population, the demand in Puerto Rico for land is ever increasing. The island cannot afford the luxury of idle land, but must rather improve production at a rate to keep pace with, and even to surpass, the population growth. The objective of a land policy for the coffee area, then, is to ascertain the wisest and most efficient method of land use, so as to increase as greatly and rapidly as possible the income and welfare of the population.

The hurricane notwithstanding, there is little or no question but that the type of crop best suited to the coffee area is either grass or a tree crop, for the reason that these types of vegetative cover best protect the soil against erosion. Because of the heavy rainfall and steep slopes, erosion is very rapid in this area, especially if the land is clean cultivated. The prevention of soil loss is imperative if the productivity of the land is to endure. Moreover, grass-or tree-cover minimizes the silting of reservoirs and helps to maintain the island's water supply by retarding run-off.

A grass cover would invite livestock farming, an extensive type of agriculture. This type of farming warrants little consideration, because it could not support the population at as high an economic level as does coffee. The income per cuerda and per inhabitant from the production of livestock is lower than that from coffee.

Except for coffee, the experience of growing trees, of which there is a wide variety available, is not encouraging as a prospective method of land use. From the resulting wood products a gross return of about five dollars per cuerda is about all that reasonably could be expected. Furthermore, a greater length of time is required to restore such a crop to full production after destruction from a hurricane than is necessary for any of the tropical fruit trees.

An examination of tropical crops bearing fruits of commer-

cial value reveals that, under the environmental conditions of climate and soil that are inherent in the coffee area, there are only a few that could be grown profitably. These are coffee, plantains, bananas, oranges, avocados, and mangoes.¹ During World War II, at least, vanilla was grown at a profit. But the world demand is not great enough to absorb the production from the acreage Puerto Rico has available for the growing of this crop. The coffee area could not produce profitably certain of the other crops environmentally suited to it, because they can be grown so much more cheaply in countries possessing better soils or cheaper labor, or both. The other few crops that can be grown successfully on a commercial basis do not as a group furnish a substitute for coffee. Inevitably the conclusion is reached that the tree crop most suited to large-scale production in the physical environment of the coffee area and the needs of Puerto Rico is coffee, in spite of the handicaps under which it labors.

The present variety of tree crops will continue in production. It may be that others will be introduced on a small scale, but as yet there is no known full-scale substitute for coffee culture for this area. Puerto Rico probably will abide by the sound economic principles of specializing in the production of those crops in which it has the greatest comparative advantage. That is, the area will grow those crops that it can produce most cheaply in order to obtain the maximum purchasing power for the purchase of other goods, even though other countries can raise the same crop at a lower cost.

Alternative Land Policies

In examining this question three possible alternatives for a land policy in the coffee area were considered. The first is to remove all coffee subsidies, direct and indirect, and to let the industry seek its own level. Under these circumstances, assuming present production practices, the island's output of coffee could

¹The following plants comprise a partial list of the crops that have been considered by one research group or another for possible adoption in Puerto Rico: abaca (manila hemp), babassu nuts, cacao, castor beans, chicle, cinchona, cinnamon, clove, derris, ginger, henequen and sisal, kapok, lemon grass, nutmeg, palm (oil), quebracho wood, tapioca, tonka beans, and vanilla.

be expected to decrease drastically. Most, but not all, of the land devoted to coffee would be submarginal. These lands would be abandoned of coffee and become less productive. In all likelihood, a small amount of coffee would still be produced on subsistence farms. The highly efficient farm, the extremely remote farm, and the farm producing a high-quality product might also continue in operation. Coffee production would meet but a small proportion of the domestic requirements. In large measure, land now planted to coffee would provide charcoal, fruits, and some timber for the insular market. The level of living of the farmers would decline sharply, and many persons would migrate to other areas in the island adding to the unemployment problems of an already overburdened society.

The second alternative land policy is to confine governmental assistance to the maintenance of coffee subsidies at their present level and even to increase them if the economic conditions of the coffee farmer seem, to those in authority, to justify such action. This is the policy that is currently in effect. Under this policy there appears little prospect of improving the economic and social lot of the coffee farmer, unless subsidies were increased, but, on the other hand, conditions might not get worse.

The third alternative is to strive for a more efficient use of all lands in the coffee area. Such a policy has as its objectives the attainment of the highest possible level of living for the coffee farmer, and possibly the gradual removal, in part or in whole, of the coffee subsidies. To achieve these ends, the trend of coffee production, which showed a decrease of 38.1 per cent between 1910 and 1940, must be reversed.

Greater efficiency in the use of land may be achieved by the employment on coffee plantations of the modern farming practices recommended by the governmental agencies (chap. iii), and the intensive utilization of all land in the area. As a caveat, it should be noted that such a policy, even if wisely and vigorously implemented, will require many years to reach fruition. The occurrence of hurricanes would delay rehabilitation. In large measure the success of such a policy requires the education of the farmer in efficient agricultural practices. To surmount prejudice, ignorance, indifference, and poor habits will be difficult and time-consuming.

With these reservations, there is a good reason to believe

that important and rewarding increases in production could be achieved over a period of several years. On the basis of the handful of farmers who have adopted good farming practices, of the judgment of agencies with experience in the coffee problem, and of field observation, the potentialities are encouraging. Coffee yields alone can be increased four or five times above the present average (1945-46 crop year) before reaching the point of diminishing returns in the application of labor and capital. The maximum yields reasonably to be anticipated are unknown for lack of adequate experimental data and records from well managed farms.

Increasing the productivity of coffee plantings is only one phase of a land policy. As has been noted, coffee farming is diversified. The sale of bananas, plantains, oranges, other fruits and vegetables, and charcoal also provides farm revenue, and their production, too, can be increased by the application of better farming techniques, such as the use of improved seed and fertilizer. Pasture land throughout the area could be made more productive. Pastures, commonly, are in part grown up to brush and trees, thereby reducing the carrying capacity of the land. The native grasses are low in nutrients. The gradual clearing of brush from pastures, and the planting of good grasses, of which there are several, such as tropical Kudzu for the poorer soils and warmer climates, and such as mercer grass, Guatemala, and Yaragua (molasses grass) for the cooler sections, could, it is believed, increase the carrying capacity several times. Also, the least fertile land may be used for forestry. However small the income, it is a method of land use that cannot be overlooked by a community whose income is meager.

Other improvements in land use are also possible, as, for example, developing more productive strains of beef and dairy cattle,¹ adopting better pasture management practices, and increasing the number of home vegetable gardens. It is noteworthy that any encouragement given to achieve a greater self-sufficiency on the coffee farm through the increased production of foodstuffs for home use should be made with the realization that such a system is primarily intended to supplement present incomes and to increase the supply of food on the island, and that in itself it is neither a substitute for commercial agriculture nor a solution of the cof-

¹Efforts in this direction are currently being made by the Puerto Rico Agricultural Development Company.

fee area's problems.

The efficient and balanced use of all lands would result in crop diversification; an increase in gross annual earnings; a more even distribution of income throughout the year; a spreading of risk over a wide variety of crops; a greater economic resiliency with which to recover from hurricanes; and an enhanced borrowing power, because of the improved risk and earning capacity of the farm.

In large measure, knowledge is at hand to cope with the broad problem of low yields (chap. iii). Added research into the several phases of production would, however, facilitate a detailed prescription for the appropriate utilization of individual plots of land, and would further enrich the efforts of rehabilitation. For example, a comprehensive research program might include:

- (1) a farm management study for several successive years of identical farms distributed over the entire coffee area. These should be selected in such a manner as to derive accurate correlations between yields and quality on the one hand, and the physical factors of soil, elevation, climate, and slope on the other hand.
- (2) A comparative study of production methods in other "mild" coffee-producing countries adjoining the Caribbean.
- (3) Experiments in the techniques of drying coffee after harvest, so as to secure the highest-quality product.
- (4) Experiments in the field of agronomy designed to increase yields of both coffee and secondary crops under the several sets of the soil-elevation-climate-slope complexes existing in the coffee area.
- (5) The mapping in detail of present land use and soil capabilities of the area.

Thus far, discussion of remedial action has centered on aspects of production. On the other side of the medallion is the marketing phase of the industry. The two are of the same coin. Standing out in bold relief is the fact that while Puerto Rico has the largest producing area of coffee under the United States flag, the island has no assigned niche for its high-quality product in that market, or, for that matter, in any other market of the world. Reasons for past failure are clear (chap. iv). Not so evident is the fact that this position must necessarily endure.

Findings of this dissertation suggest that there is much to be learned in the field of coffee marketing which may prove profitable when applied to the problems of Puerto Rico. If a competent coffee-marketing research program were to be launched, prom-

ising avenues of investigation might well include: (1) a comparative study of marketing methods in other Central American and West Indian coffee-producing countries; (2) an examination of coffee-consumer tastes and habits, as well as of the requirements and practices of roasters and blenders, in New York, New Orleans, and San Francisco, the three most important coffee-trading centers in the United States; and (3) a similar analysis in the coffee-consuming countries of Europe, where the war has wrought great changes in buying habits, the ultimate features of which are not yet clear.

The results of scientific research along channels such as these might enable Puerto Rico effectively to reorient its production and marketing efforts in such a manner as to obtain a higher income for the coffee area. For an industry that is subsidized to the extent of approximately \$3,500,000 annually, the added cost of a thorough production and marketing study would be a negligible investment.

Research can be accomplished with the addition of trained personnel, by such groups as the experiment stations, Bureau of Agricultural Economics, University of Puerto Rico, Cafeteros de Puerto Rico, Agricultural Development Company, Department of Agriculture and Commerce, and the Soil Conservation Service.

The implementation of research findings is in itself a difficult problem. Existing agencies, however, also provide a vehicle for the application of presently known procedures, as well as of new findings, to the production and marketing problems. The most notable of these are the Agricultural Extension Service, Agricultural Development Company, Coffee Industry Relief Commission, Farm Security Administration, Cafeteros de Puerto Rico, Land Authority, and the Coffee Insurance Corporation.

In conclusion, it appears that in spite of the disadvantages inherent in the coffee culture in Puerto Rico, the island has little choice but to make the best of an unfortunate situation, namely, to develop as efficient a coffee economy as possible. It would seem, however, that there is little prospect that any program, however successful, can achieve much more than the equivalent of a removal of the subsidies and a doubling of present income. An achievement of such proportions would, of course, be of immense value to the island. Not since World War I have the prospective short-run coffee price factors appeared so favorable. The next five-year period would seem the most propitious time in a genera-

tion, therefore, in which to inaugurate a program of land rehabilitation in the Puerto Rico coffee area.

APPENDIX I

TABLE 1
AVERAGE MONTHLY TEMPERATURES FOR SELECTED
STATIONS IN PUERTO RICO^a
(in °F.)

Station	Janu- ary	Febru- ary	March	April	May	June	July	August	Septem- ber	Octo- ber	Novem- ber	Decem- ber	Annual
Jayuya.....	71.4	71.6	72.0	72.9	74.7	76.5	77.3	77.7	77.1	76.2	74.8	72.6	74.6
Lares.....	72.0	71.6	72.6	73.8	75.3	76.5	77.1	77.4	77.1	76.6	75.4	73.2	74.9
Maricao.....	70.1	69.7	69.9	71.1	72.1	73.5	74.0	74.7	73.4	72.7	72.1	70.9	72.0
Mayaguez.....	74.5	74.4	74.3	75.0	77.8	78.8	78.9	79.2	79.4	79.1	77.6	76.1	77.2

^a Sources: Soil Survey of Puerto Rico; Meteorological Summary with Comparative Data.

TABLE 2
AVERAGE MONTHLY PRECIPITATION FOR SELECTED
STATIONS IN PUERTO RICO^a
(in inches)

Station	Janu- ary	Febru- ary	March	April	May	June	July	August	Septem- ber	Octo- ber	Novem- ber	Decem- ber	Annual
Añasco.....	1.52	2.90	2.82	5.63	8.71	10.15	11.63	12.21	11.05	10.47	6.26	2.84	86.19
Jayuya.....	4.65	3.13	3.81	4.47	5.87	4.92	6.90	8.41	4.92	10.25	7.11	4.68	73.52
Lares.....	2.93	3.53	4.63	8.34	13.86	9.62	7.94	9.97	11.86	12.13	8.20	4.51	97.54
Las Marias...	2.75	2.61	4.72	6.49	12.37	10.66	9.34	12.14	13.24	12.39	8.97	3.72	99.38
Maricao.....	2.13	3.15	5.37	8.10	12.43	8.00	11.70	14.26	15.43	15.11	8.40	3.75	107.73
Mayaguez.....	1.98	2.12	3.91	5.14	8.30	8.88	10.84	11.25	10.75	9.62	5.90	2.62	81.31
Orocovis.....	5.63	3.15	5.89	4.93	9.37	4.13	7.35	4.58	8.34	8.93	8.98	7.68	78.96
San Sebastian	3.64	2.45	4.94	8.24	13.29	12.47	9.58	11.01	12.59	11.91	9.01	3.96	103.09
Utua.....	3.72	1.85	3.64	6.94	8.19	7.86	6.47	7.68	12.75	10.24	7.66	3.89	80.89

^a Sources: Soil Survey of Puerto Rico; Meteorological Summary with Comparative Data.

TABLE 4

OCCUPATIONS OF EMPLOYED PERSONS IN PUERTO RICO AND THE COFFEE AREA,^a BY SEX, 1940^b

Occupation	Total Puerto Rico	Male		Female		Total Coffee Area
		Puerto Rico	Coffee Area	Puerto Rico	Coffee Area	
Total.....	512,214	383,914	36,988	128,000	12,666	49,654
Professional and semiprofessional workers....	15,287	7,540	445	7,757	486	931
Farmers and farm managers.....	47,761	44,691	7,525	3,070	545	8,070
Farmers.....	46,142	43,083	7,236	2,959	536	7,772
Coffee farms.....	6,953	6,437	3,450	516	276	3,726
Sugar-cane farms.....	5,336	4,994	321	342	21	342
Tobacco farms.....	5,578	5,239	701	239	42	743
All other farms.....	28,275	26,413	2,764	1,862	197	2,961
Farm managers.....	1,719	1,608	289	111	9	298
Coffee farms.....	426	418	221	8	5	226
Sugar-cane farms.....	376	366	27	10	-	27
Tobacco farms.....	179	174	11	5	-	12
All other farms.....	738	650	80	88	3	33
Farm laborers and foremen.....	178,304	175,354	21,056	2,950	421	21,477
Farm foremen.....	5,096	5,087	675	9	1	676
Coffee farms.....	860	855	497	5	-	497
Sugar-cane farms.....	3,304	3,301	128	3	1	129
Tobacco farms.....	202	201	19	1	-	19
All other farms.....	730	730	31	-	-	31
Farm laborers (wage workers).....	159,318	156,960	18,275	2,358	343	18,618
Coffee farms.....	15,334	15,191	9,112	143	77	9,189
Sugar-cane farms.....	111,835	111,201	5,683	634	28	5,721
Tobacco farms.....	10,010	8,874	1,233	1,136	201	1,534
All other farms.....	22,139	21,694	2,137	445	37	2,174
Farm laborers (unpaid family workers).....	13,890	13,307	2,106	583	77	2,183
Coffee farms.....	1,933	1,890	1,057	43	27	1,084
Sugar-cane farms.....	1,361	1,338	126	23	4	130
Tobacco farms.....	2,249	2,030	233	219	31	264
All other farms.....	8,347	8,049	690	298	15	705

TABLE 4--Continued

Occupation	Total Puerto Rico	Male		Female		Total Coffee Area
		Puerto Rico	Coffee Area	Puerto Rico	Coffee Area	
Proprietors, managers, officials, except farm	24,380	22,310	1,530	2,070	127	1,657
Clerical workers.....	41,539	33,488	1,558	8,051	245	1,803
Craftsmen.....	27,550	27,334	1,093	216	6	1,099
Operatives.....	91,651	27,898	1,375	63,753	8,021	9,396
Domestic-service workers.....	39,335	4,042	1,394	35,293	2,521	2,915
Protective-service workers.....	7,200	7,145	167	55	-	167
Service workers, except domestic and protec- tive.....	11,307	6,993	344	4,314	236	580
Laborers, except farm.....	26,274	25,924	1,385	350	11	1,396
Occupation not reported.....	1,616	1,195	116	421	47	163

^aThe "coffee area," in this instance, is Region 6, as used by the census, and includes the municipalities of Adjuntas, Ciales, Jayuya, Lares, Las Marias, Maricao, San Sebastian, and Utuado.

^bSource: Sixteenth Census of the United States, 1940. Population, Bulletin No. 3 (Washington: Government Printing Office, 1943), pp. 54-59.

TABLE 8
NUMBER, ACREAGE, AND VALUE OF FARMS, BY TYPE--1935^a
(in thousands of cuerdas)^b

Type of Farm	Number of Farms	All Land in Farms	Cropland			Pasture			Other Wood-land	All Other Land	Value of Land and Buildings (Per Farm)
			Total	Har-vested	Idle	Total	Clear	Wood-land			
Sugar cane.....	6,620	758.8	346.2	299.9	46.2	312.8	276.9	35.9	27.5	72.4	13,225
Coffee.....	9,644	401.3	208.4	189.7	18.6	98.4	79.2	19.2	47.4	47.2	2,671
Tobacco.....	13,016	252.2	105.5	85.0	20.5	99.0	88.4	10.6	12.9	34.8	986
Coffee--tobacco	1,596	65.2	30.2	25.0	5.3	20.7	16.8	3.8	5.1	9.2	2,086
Minor crops.....	18,753	243.7	103.3	84.2	19.0	92.0	79.1	12.9	14.7	33.7	543
Other farms.....	3,161	191.8	33.8	27.3	6.5	131.4	115.8	15.6	11.7	14.8	5,260

^a Source: Census of Puerto Rico, 1935.

^b One cuerda equals 0.9712 acres, or 42,305 square feet.

TABLE 10

CALENDAR OF AGRICULTURAL PRACTICES ON COFFEE FARMS
(Crops utilizing more than one per cent
of the land under cultivation)

Month	Coffee	Plantains and bananas
January	Harvesting. Preparation of nursery. Collecting seedlings. Weeding. Picking. Fertilizing trees in production (10-5-15).	Planting. Preparing soil. Harvesting. Removing weevils.
February	Weeding. Preparing nursery. Cultivation.	
March	Planting seedlings in nursery. Cultivation. Preparation of ground for planting.	Planting. Fertilizing. Removing weevils. Harvesting.
April	Planting seedlings in nursery. Cultivation. Preparation of ground for planting.	Planting. Fertilizing. Removing weevils. Harvesting.
May	Second fertilizing, trees not in production (8-3-10).	Planting. Removing weevils.
June	Second fertilizing, trees not in production (8-3-10). Weeding.	
July	Second fertilizing of coffee not in production. Planting. Weeding.	Cultivation and harvesting.
August	Planting. Transplanting to the nursery. Selecting seedlings.	Planting. Harvesting. Removing weevils.
September	Harvesting. Planting. Transplanting to the nursery. Selecting seedlings.	Fertilizing. Planting. Harvesting.
October	Harvesting. Planting. Transplanting to the nursery. Collecting seeds. Fertilizing trees in production (10-5-15).	Selecting seed. Preparing soil. Fertilizing. Removing weevils.
November	Harvesting. Preparation of nursery. Collecting seedlings. Weeding. Picking. Fertilizing trees in production (10-5-15).	Selecting seed. Preparing soil. Removing weevils.
December	Harvesting. Preparation of nursery. Collecting seedlings. Weeding. Picking. Fertilizing trees in production (10-5-15).	Selecting seed. Preparing soil. Cultivating. Removing weevils.

TABLE 10--Continued

Sugar Cane (ratoon)	Beans	Oranges	Corn
Harvesting. Preparing terraces.	Harvesting.	Harvesting. Grafting. Prun- ing. Fertiliz- ing. Spraying.	
Harvesting. Preparing terraces.	Harvesting. Pre- paring the land.	Harvesting. Grafting. Spraying.	Preparing the land. Harvesting.
Harvesting. Preparing terraces	Planting. Prepar- ing the land.	Grafting. Spraying.	Preparing the land. Destroy- ing insects.
Harvesting. Preparing terraces.	Planting. Prepar- ing the land. Weeding.	Transplanting. Fertilizing. Spraying.	Planting. Prepar- ing the land. Weeding. Destroy- ing insects.
Harvesting. Preparing terraces.	Weeding. Harvesting	Transplanting. Fertilizing. Spraying.	Cultivating. Planting. De- stroying insects.
Harvesting. Preparing terraces.	Harvesting.	Cultivating. Planting. Har- vesting. Spraying.	Weeding. Destroy- ing insects.
Cultivation.		Cultivating. Planting. Har- vesting. Spray- ing.	Harvesting.
Cultivation.		Harvesting. Planting. Spraying.	Preparing the land. Harvest- ing. Planting.
Cultivation.	Preparing the land.	Planting seed. Harvesting. Planting.	Preparing the land. Harvest- ing. Planting.
	Planting.	Harvesting. Spraying.	
	Planting. Weeding.	Pruning. Spraying.	Weeding. Destroy- ing pests.
	Planting. Weeding. Harvesting.	Pruning. Spraying. Fertilizing.	Weeding. Destroy- ing insects.

TABLE 14

NUMBER, ACREAGE, AND VALUE OF COFFEE FARMS, BY TENURE--1935^a

	Owners	Managers	Tenants	Total
Number of farms.....	8,002	758	884	9,644
All land in farms (cuerdas).....	280,914	90,973	29,455	401,342
Cropland				
Total.....	144,675	50,166	13,543	208,384
Harvested.....	130,914	46,824	11,999	189,737
Idle.....	13,761	3,342	1,544	18,647
Pasture				
Total.....	71,544	18,141	8,714	98,399
Clear.....	58,307	14,664	6,248	79,219
Woodland.....	13,237	3,477	2,466	19,180
Other woodland.....	31,153	12,143	4,093	47,394
All other land.....	33,537	10,523	3,105	47,165
Value of land and buildings				
Total.....	\$17,802,329	\$6,278,262	\$1,679,033	\$25,759,624
Per farm.....	2,225	8,283	1,899	2,671
Per cuerda.....	63.27	69.01	57.00	64.18
Per cent distribu- tion				
Farms.....	82.8%	7.9%	9.3%	100.0%
All land in farms.	70.0	22.7	7.3	100.0
Total cropland....	69.4	24.1	6.5	100.0

^aSource: Census of Puerto Rico, 1935.

TABLE 16

LOCATION OF FARMS IN THE COFFEE AREA, WITH RESPECT TO ROADS--1939^a

Municipality	Farms Reported as Located on a Road		Farms Reported as Not Located on a Road					
	Total	Per Cent	Total	Per Cent	1/2 km. or Less		Over 1/2 km. and Not More than 1 km.	
					Number	Per Cent	Number	Per Cent
Adjuntas..	1,191	17	205	83	42	-	131	--
Ciales....	1,360	10	142	90	78	6	148	12
Jayuya....	499	14	67	86	22	4	52	10
Lares.....	1,525	18	276	82	85	6	136	9
Las Marias	678	14	94	86	27	4	54	8
Maricao....	229	27	62	73	12	5	20	9
Utuaado....	2,788	10	268	90	246	9	310	11
Total....	8,270	13	1,114	87	512	6	851	10
								71

^a Source: Census of Puerto Rico, 1940.

TABLE 22

PRODUCTION, IMPORTS, EXPORTS, AND CONSUMPTION OF COFFEE
IN PUERTO RICO, BY CROP YEARS, 1925-46^a

Years	Production	Imports	Exports	Consumption
1925-26.....	36,334,570	21,653	26,332,756	10,023,467
1926-27.....	39,124,693	424	19,356,904	19,768,212
1927-28.....	32,393,259	1,205,823	7,837,800	25,761,281
1928-29.....	18,446,602	5,476,298	1,428,757	22,494,143
1929-30.....	5,351,599	10,247,035	433,901	15,164,733
1930-31.....	6,000,000	6,225,827	1,977,779	10,248,048
1931-32.....	10,090,219	2,062,493	589,602	11,563,110
1932-33.....	11,381,096	1,366,498	549,839	12,197,755
1933-34.....	9,000,000	16,449	2,969,505	6,046,944
1934-35.....	8,000,000	1,412,699	799,950	8,612,749
1935-36.....	20,000,000	18,948	2,465,133	17,553,815
1936-37.....	20,536,996	17,102	8,340,114	12,213,984
1937-38.....	16,639,200	6,078	592,807	16,052,471
1938-39.....	18,949,198	6,113	3,667,104	15,288,207
1939-40.....	23,498,000	8,560	3,644,385	19,863,175
1940-41.....	16,200,000	32,451	8,195,274	8,037,177
1941-42.....	29,593,000	12,279	7,633,681	21,981,598
1942-43.....	16,959,000	1,397	1,393,524	15,566,873
1943-44.....	22,231,700			
1944-45.....	30,094,700			
1945-46.....	13,796,100 ^b			15,000,000 ^b
Average 1925-43...	18,805,400	1,557,600	5,450,500	14,917,776

^aSources: Annual Book on Statistics of Puerto Rico; La Perspectiva del Cafe en Puerto Rico para el Año 1945-46.

^bEstimate.

TABLE 23

WORLD IMPORTS OF COFFEE^a
(in million bags of 60 kilos each)

Area	1935-39	1940-44	1945	1946-50 ^b
United States.....	13.9	16.4	20.5	20.0
Total--Europe.....	11.5	2.7 ^b	3.6 ^b	6.0
Total--Other.....	2.2	2.1 ^b	2.2 ^b	2.5
Total--World.....	27.6	21.2	26.3	28.5

^aSource: Synopsis and Summary of the World Coffee Situation.

^bEstimated.

TABLE 24

WORLD EXPORTABLE PRODUCTION OF COFFEE^a
(in million bags of 60 kilos each)

Area	1935-39	1940-44	1945	1946-50 ^b
Brazil.....	22.4	15.4	8.3	15.0
Colombia.....	4.0	4.9	5.1	5.4
Total 12 American republics.	4.6	4.1	4.5	4.5
Netherlands East Indies.....	1.4	n.a. ^c	.0 ^b	.8
Other areas.....	2.6	2.5	3.1	3.5
Total--World.....	35.0	26.9	21.0	29.2

^aSource: Synopsis and Summary of the World Coffee Situation.

^bEstimated.

^cNot available.

APPENDIX II

LAWS OF PUERTO RICO PERTAINING TO COFFEE

Law Levying an Import Duty on Foreign Coffee

No. 77, approved May 5, 1931, and amended in 1934 and 1935.

This law imposes a tax of 15 cents per pound of green coffee and 18 cents per pound of roasted or ground coffee, said tax to be collected by the Federal Customs House Service established in Puerto Rico.

Law Providing for the Necessary Punishment for the Adulteration of Coffee in Puerto Rico

No. 24, approved April 20, 1928.

This measure declares as illegal the adulteration or mixing of coffee, in grain, crushed or ground with other grain or substance, for the purpose of selling, offering or having it for sale; it shall be equally illegal that said adulterated or mixed coffee be sold, offered or kept for sale, or transported or stored for the purpose of using it for human consumption or using it for industrial purposes when used in the preparation of food for human consumption.

Law Fixing the Minimum Selling Price for Puerto Rican Coffee and Establishing Consumption and Surplus Quotas per Coffee Farm in Puerto Rico

No. 255, approved May 15, 1938, amended by Law No. 124 of May 6, 1939, No. 112 of May 1, 1940, and by No. 131 of May 2, 1940.

This law regulates the price of coffee in Puerto Rico and establishes consumption and surplus quotas per coffee farm in Puerto Rico, having a specific disposition as to the setting of selling prices. It also prescribes the simultaneous delivery on the part of the coffee farmers of both quotas, consumption and surplus, in the measure established by the Commissioner of Agriculture and Commerce, as concerns each sale or transfer of part of or all the coffee harvest; it also establishes general administrative procedure to be followed in coffee embargo cases which do not adhere to the dispositions of the law and the regulations established by the Commissioner of Agriculture and Commerce. It contains dispositions to prevent the purchase and sale of coffee corresponding to the surplus quota of coffee for consumption.

Law Regulating the Sale of Coffee in Puerto Rico

No. 3, approved July 11, 1935, and amended by Law No. 248 of May 15, 1938, and No. 111 of May 1, 1940.

This law authorizes the Commissioner of Agriculture and Commerce to regulate the sale of coffee in Puerto Rico through the issue of licenses to the wholesale dealers, roasters and coffee grinders. This measure, in conjunction with other coffee laws, helps to decrease the use and consumption of foreign coffees in Puerto Rico and prevents the adulteration of roasted and ground coffee served to the Puerto Rican consumer.

It authorizes the Commissioner of Agriculture and Commerce to levy and collect administrative fines for violations of the dispositions of the law or of regulations promulgated in accordance with the law and for misdemeanors; after due prosecution, giving the party prosecuted the right to request transfer of the case to the Department of Agriculture and Commerce, before it is prosecuted. This measure gives wide authority to the officials of the Department of Agriculture and Commerce in seeing that the law is enforced, through the embargo of coffee.

Law Protecting the Coffee in Puerto Rico from Existing Pests in Other Countries and Ratifying Conjunct Resolution No. 13 1/2 Approved on April 30, 1925

No. 184, approved May 11, 1938.

This law ratifies Conjunct Resolution No. 13 1/2, approved April 30, 1925, and its purpose is to protect the coffee in Puerto Rico from existing pests in other countries; towards this end it prohibits the introduction in Puerto Rico of seeds, plants and grains of coffee or of containers used for coffee coming from countries where the "Stephanaderes Coffeaeae" insect exists, or from any other country where plants, seeds or grains of coffee coming from the aforementioned countries have been imported, this prohibition not including the toasted or ground coffee.

Law Abolishing the Conjunct Resolution Which Imposed a Tax on Each Cuerda of Coffee

No. 260, approved May 15, 1938.

This law abolishes Conjunct Resolution No. 4, approved July 16, 1932, which imposed a special tax of one or two per cent on each assessed cuerda of coffee, created by the "Fondo de Seguro y Rehabilitación Cafetera," and authorized the Government of Puerto Rico, through the Commissioner of Agriculture and Commerce, either independently or in co-operation with agencies extending credit facilities to coffee farmers to purchase the necessary amount of insurance to insure the plantations, harvest or credit of the coffee farmers in the Island who had requested or obtained loans from the agencies authorized and ready to make loans in the Island of Puerto Rico.

Law Cancelling and Condonating the Taxes Indebted
by Coffee Farms and Setting the Type of Tax

No. 35, approved April 28, 1932.

This law authorizes the Treasurer of Puerto Rico to cancel the receipts for taxes on coffee farms for the fiscal year 1928-29, pending collection while the law was in effect; to cancel the receipts for the second semester for each of the fiscal years 1929-30, 1930-31 and for the coffee farms which had not been reassessed during said years by the "Junta de Revisión e Igualamiento." This law requires at the same time that the taxes fixed by the "Junta de Revisión e Igualamiento" for all the coffee farms for the year 1931-32, cannot be increased by the Treasurer of Puerto Rico during the four years after the approval of the law.

Law Extending Taxes Fixed by the "Junta de
Revisión e Igualamiento"

No. 272, approved May 15, 1938.

This measure authorizes the Treasurer of Puerto Rico to extend for an additional period of four years following the approval of this law, the taxes fixed by the "Junta de Revisión e Igualamiento" for all coffee farms for the fiscal year 1931-32. This measure is based on the policy of Puerto Rico to protect the coffee industry of the Island and to contribute to the development and rehabilitation of coffee farms, stimulating production and co-operating in the development of a normal market for the harvest.

Law Establishing Hurricane Insurance for Coffee
in Puerto Rico, and Creating The Coffee
Insurance Corporation of Puerto Rico

No. 278, approved April 5, 1946.

This law authorizes the creation of a coffee insurance program, financed by an appropriation of \$4,950,000, to alleviate the losses of coffee farms sustained by hurricanes.

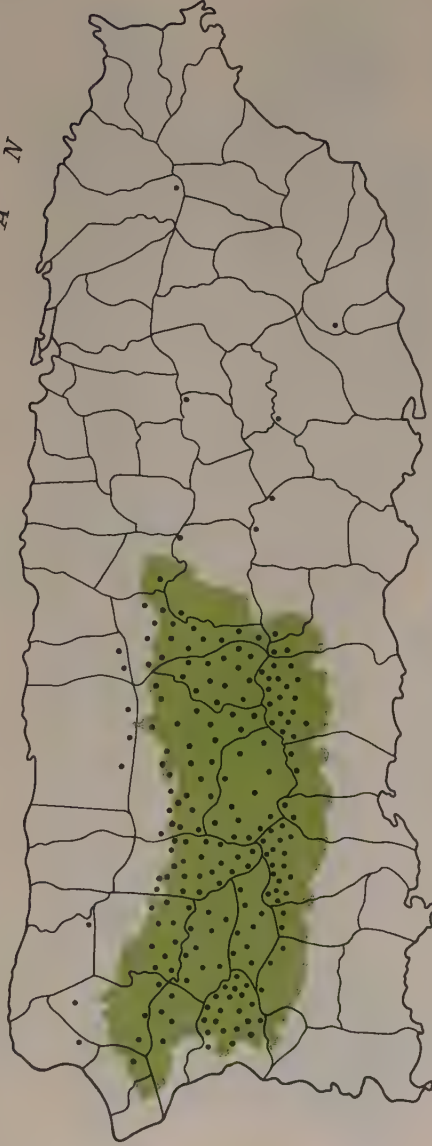
Law Establishing the Puerto Rico Coffee
Industry Relief Commission

No. 198, approved March 25, 1946.

This law authorizes the creation of a coffee industry relief commission to prepare and put into effect a general plan for the rehabilitation of the coffee industry. An appropriation of \$800,000 was made to finance the program for the first fiscal year.

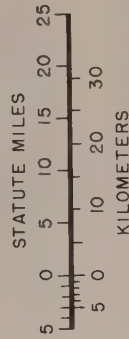
DISTRIBUTION OF COFFEE PRODUCTION, 1936 - 37

A T L A N T I C O C E A N



Each dot represents 100 quintals
(1 quintal = 100 pounds)

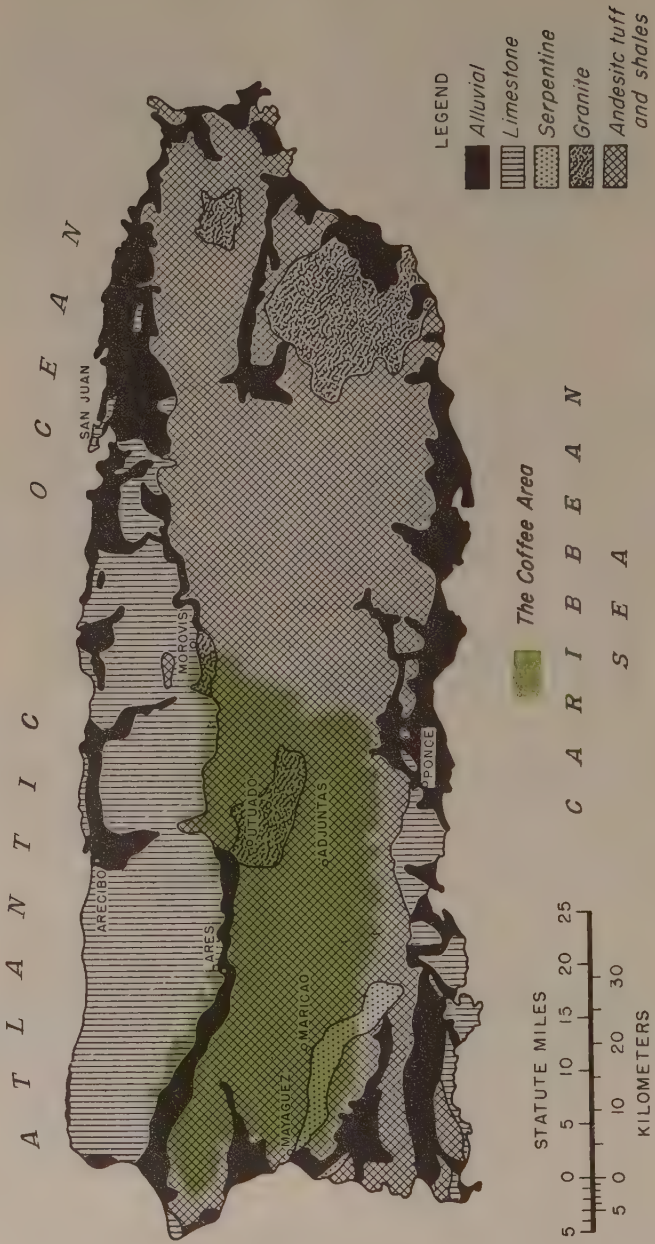
The Coffee Area
C A R I B B E A N
S E A



SOURCE: BUREAU OF AGRICULTURAL ECONOMICS, UNIVERSITY OF PUERTO RICO

Fig. 2 - Distribution of Coffee Production, 1936-37

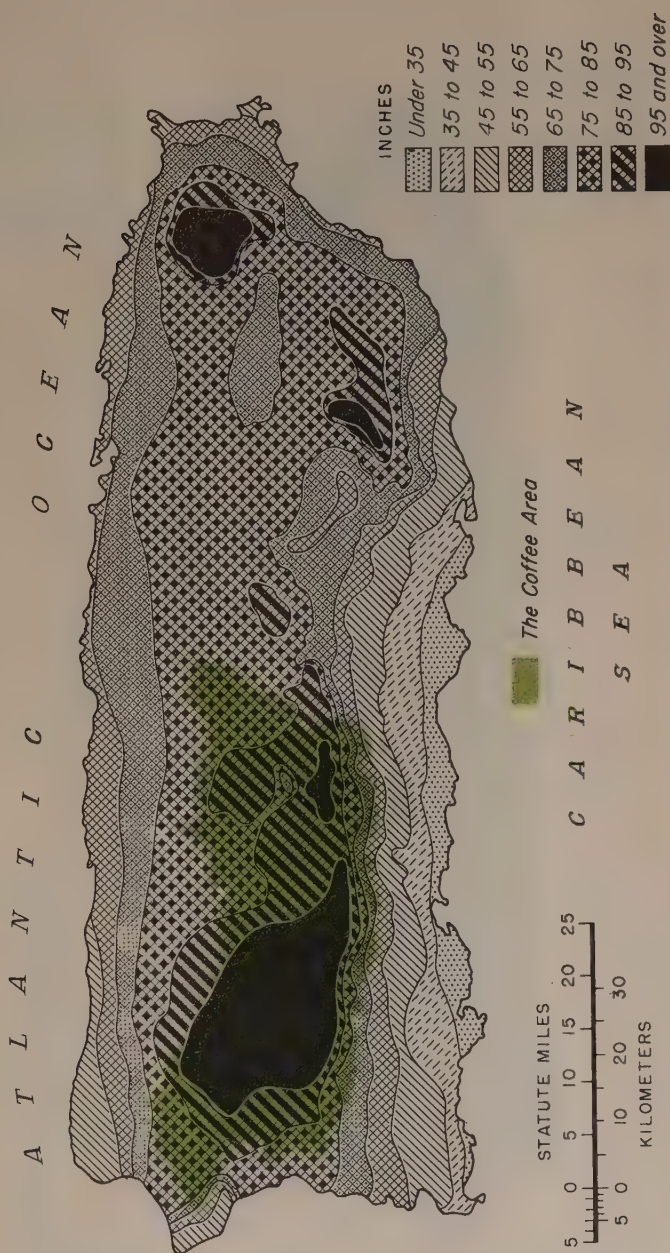
GEOLOGICAL STRUCTURE OF PUERTO RICO



ADAPTED FROM SOIL SURVEY OF PUERTO RICO

Fig. 4 - Geological Structure of Puerto Rico

DISTRIBUTION OF AVERAGE ANNUAL RAINFALL

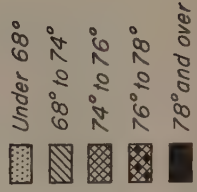
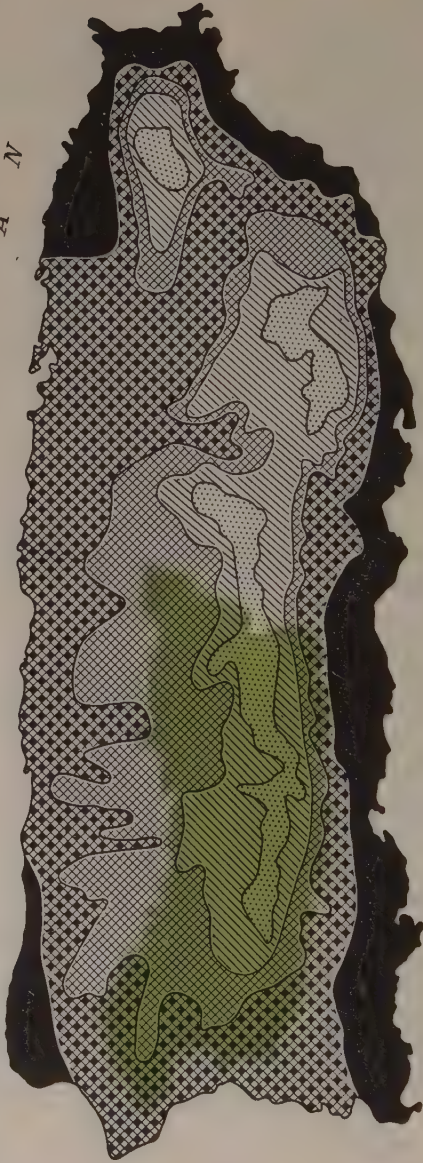


ADAPTED FROM SOIL SURVEY OF PUERTO RICO

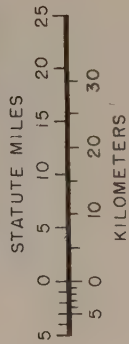
Fig. 6- Distribution of Average Annual Rainfall

DISTRIBUTION OF AVERAGE ANNUAL TEMPERATURE

A T L A N T I C O C E A N



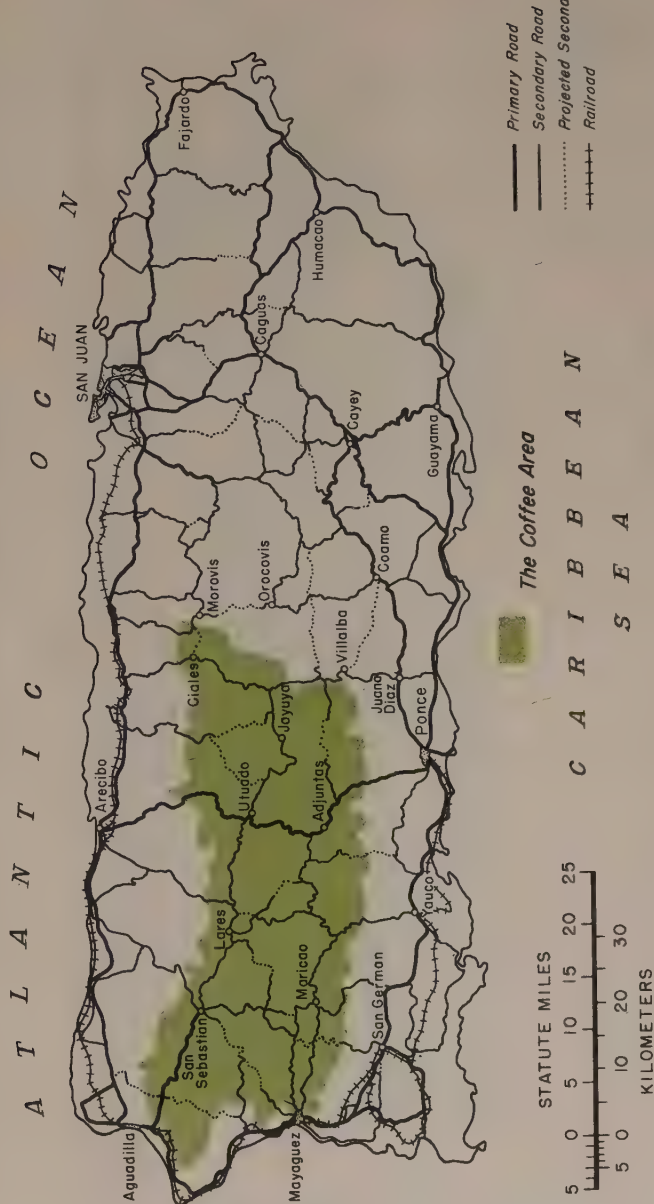
C A R I B B E A N S E A



ADAPTED FROM SOIL SURVEY OF PUERTO RICO

Fig. 7—Distribution of Average Annual Temperature

TRANSPORTATION PATTERN OF PUERTO RICO



SOURCE: PUERTO RICO PLANNING BOARD

Fig. 9 - Transportation Pattern of Puerto Rico

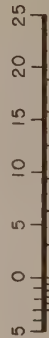
DISTRIBUTION OF POPULATION, 1940

A T L A N T I C O C E A N

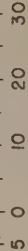


Each dot represents 1,000 persons

STATUTE MILES



KILOMETERS



The Coffee Area

C A R I B B E A N S E A

URBAN CENTERS

- Under 5,000
- 5,000 to 10,000
- 10,000 to 25,000
- 25,000 to 75,000
- 75,000 and over

SOURCE: SOIL SURVEY OF PUERTO RICO AND CENSUS OF POPULATION, 1940

Fig. 12 - Distribution of Population, 1940

AVERAGE SIZE OF COFFEE FARMS, BY MUNICIPALITIES, 1935

A T L A N T I C O C E A N



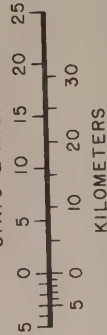
CUERDAS

(1 Cuerto = 0.97 acre)

	Under 15.9		46 - 55.9
	16 - 25.9		56 - 65.9
	26 - 35.9		66 - 75.9
	36 - 45.9		Over 75.9

41.6 cuerdas = Island average

The Coffee Area



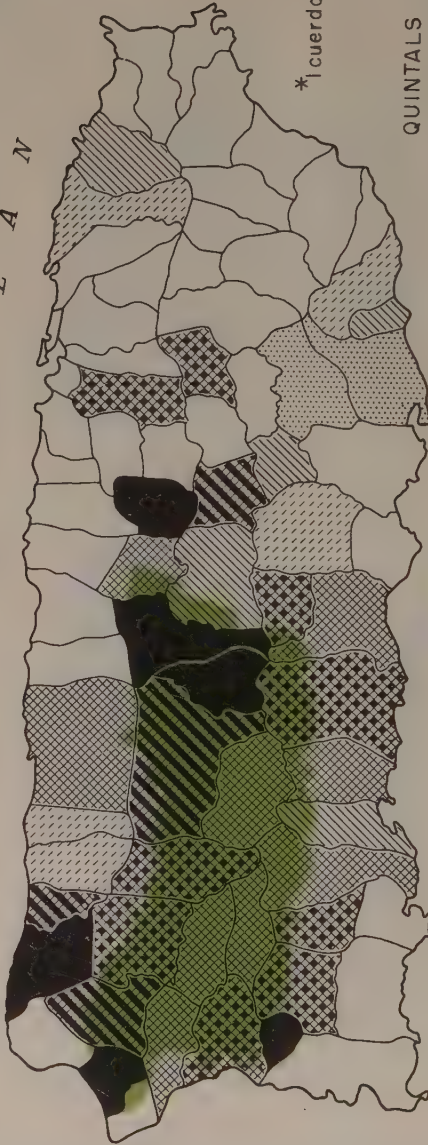
C A R I B B E A N S E A

SOURCE: CENSUS OF POPULATION, 1935

Fig. 18 - Average Size of Coffee Farms, by Municipalities, 1935

COFFEE YIELDS PER CUERDA,* BY MUNICIPALITIES, 1939-40

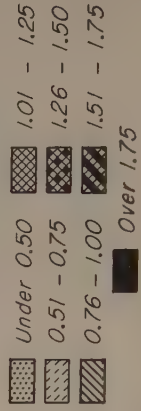
A T L A N T I C O C E A N



*1 cuerda = 0.97 acre

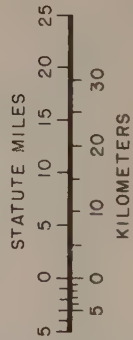
QUINTALS

(1 quintal = 100 pounds)



The Coffee Area

C A R I B B E A N
S E A

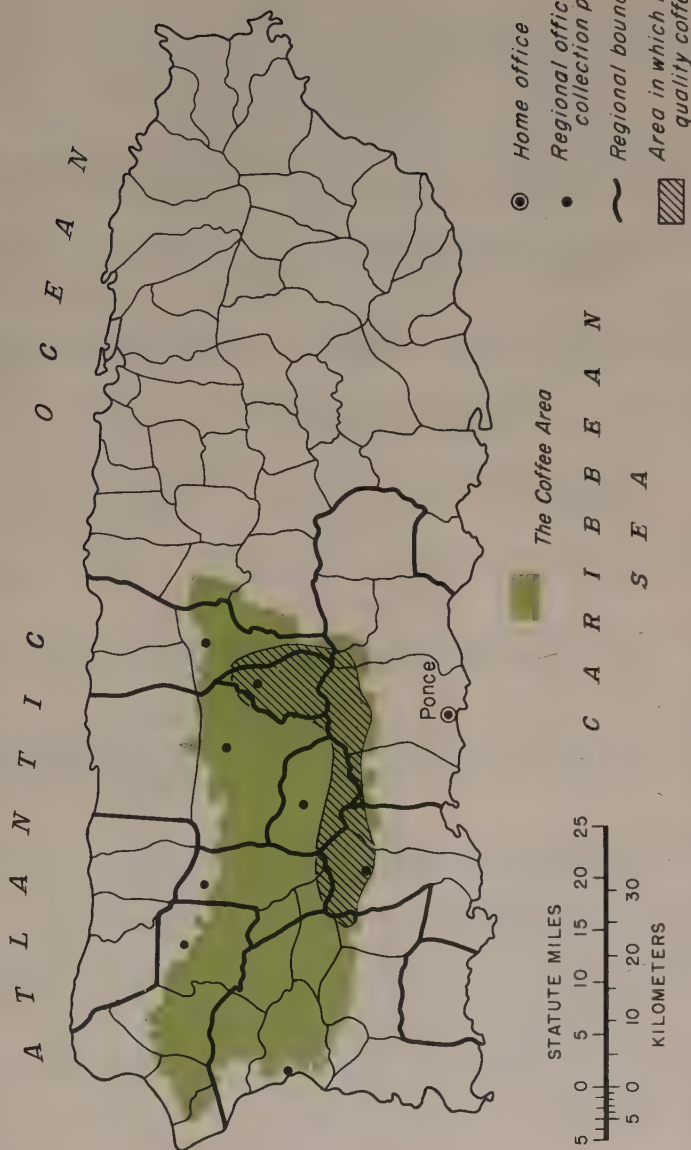


SOURCE: BUREAU OF AGRICULTURAL ECONOMICS, UNIVERSITY OF PUERTO RICO

1.33 quintals = island average 1939-40

Fig. 20- Coffee Yields per Cuerda, by Municipalities, 1939-40

ATLANTIC OCEAN TRIBUTARY AREAS FOR THE COLLECTION OF COFFEE BY THE CAFETEROS DE PUERTO RICO



SOURCE: CAFETEROS DE PUERTO RICO

Fig. 21 - Tributary Areas for the Collection of Coffee by the Cafeteros de Puerto Rico

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